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ABSTRACT

The teacher developed curriculum guide provides the industrial education teacher with the objectives, equipment lists, material, supplies, references, and activities necessary to teach students of the 9th and/or 10th grade the concepts of interrelationships between material analysis and processing systems. Career information and sociological implications are included in activity form. The course is defined as the study of organic and inorganic materials and how they are changed to satisfy man's material needs. The guide opens with orientation suggestions, safety instruction, and introductory activities. Lesson plans covering the analysis and processing of plastic, metal, wood, and earth materials fill more than 100 pages of the guide, from which the instructor may select those he wishes to use to complete a 74-day course. Each plan offers a learning activity, material and processes covered, necessary reference materials, and relevant information. Among the appendixes are a pre-post test and an attitude inventory, with answer keys, an equipment list, and a bibliography. The guide is one of the outcomes of the Secondary Exploration of Technology (SET) Project. (AJ)

ED 098343

Secondary Exploration of Technology

Material Analysis and Processing Systems

Cooperative Research - USD 446, 244, & 512 with
Kansas State College of Pittsburg & Title III
of The State Department of Education, Topeka

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CE003923

Secondary Exploration of Technology

Dear Colleague:

We are happy to forward the Materials Analysis & Processing Systems document to you. We feel that implementation of a curriculum designed around the concepts included in this document is most relevant for today's youth. We wish to admit that the curriculum contained in this document is not the answer. However, it is an answer -- an answer which has proven significant and more relevant to students than the traditional types of industrial education curriculum.

To implement the curriculum you should have available most of the equipment listed on pages 170-171. Furthermore, you should review each of the activities and plan to purchase each of the reference books listed.

Implementation of this curriculum should be preceded by an in-service training session for the teachers. Most higher educational institutions in Kansas offer an in-service seminar during the summer term.

If the S.E.T. Project staff or teachers can be of assistance to you, please do not hesitate to call. Your comments and constructive suggestions for improvement of this curriculum are solicited.

Cordially,

Harvey Dean

Harvey Dean
Director

blf

S. E. T. PROJECT

Position Paper

on the
Rationale for the Study of the Total Systems of
Materials Analysis and Processing Systems, Power, Industrial Communications Systems
within Industrial Education Classes

The basic idea of the American economic system is to provide services to people or to produce a saleable product for a profit. Industry is that portion of the economic system that provides material goods by changing raw materials into products that have greater value than the raw material. Industrial service industries are concerned with keeping such products usable.

Broad based programs such as IACP Construction and Manufacturing provide students an opportunity to investigate the concepts of the total system of industry through meaningful activities. If one is to further investigate the principles of the total system of industry at or beyond the concept level, it becomes necessary to divide the principles into meaningful sub-systems.

The sub-systems of industry are: (A) Governmental Policy (B) Business Management (C) Personnel (D) Material Analysis & Processing Systems (E) Energy Systems (F) Industrial Communications Systems.

The sub-system of Governmental Policy includes the areas of the federal monetary system, natural and/or developed resources, "rules of the game" in which private industry must operate, etc.

Business Management includes the areas of operating our industries. Management topics may be marketing, management, finance, etc.

The sub-system of Personnel includes the "people problems" of industries. Personnel areas may be health, recreation, training, retiring, education, etc.

At this point in time, the Industrial Education Field must assume that the content of the three subsystems described above are taught within other curricular areas in the schools.

The content of the three remaining sub-systems of industry should then be the responsibility of the industrial education curriculum.

The S.E.T. Project systems course in Material Analysis & Processing Systems allows students to experience the methods of processing (changing) raw materials of all kinds into saleable products. It also allows students to experiment with the similarities and differences between raw materials and processing methods.

Power evolved as the need for new material processing methods developed. The developments of power technology are available to everyone in today's society. The developments have raised America's standard of living. The system course in Power provides the student with an understanding of how man has taken the basic forms of energy and systematically converted and transmitted them to work for him. The course also allows students to investigate the function of the prime movers in our transportation systems.

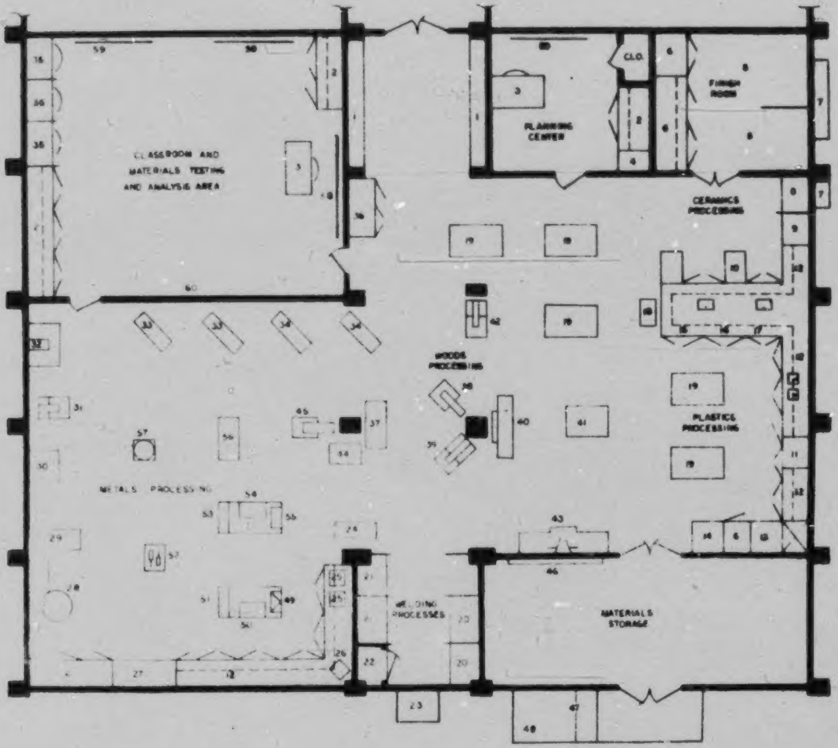
Communication has been, and still is, man's link to man and machine, and machine's link to man and other machines. In industry, communication allows one man's idea to become a reality as a saleable product. The systems course of Industrial Communications provides students with an understanding of how man can develop ideas and communicate them to other people and machines. The course includes various types of communication systems utilized in industrial settings.

Industry is a total system which includes man's changing of materials for man; utilizing the power developed by man; while communicating with all men.

It is impossible to teach the total system of Industry by selecting one element of the sub-system and developing it into a single course. However, after learners conceptualize industry and experience the system, it becomes realistic and psychologically feasible to begin studying the individual elements in individual courses.

S.E.T. Project Teachers and Staff
June, 1973

EXEMPLARY MATERIAL ANALYSIS AND PROCESSING LAB 60 x 72 FT.


CLASSROOM AND MATERIALS TESTING AND ANALYSIS AREA
PLANNING CENTER
CLO.
FINISH ROOM
CERAMICS PROCESSING
WOODS PROCESSING
PLASTICS PROCESSING
METALS PROCESSING
WELDING PROCESSES
MATERIALS STORAGE

1. display cabinet
2. cabinet/bookcase above
3. desk
4. file cabinet
5. spray booth
6. storage cabinet
7. finish vapor control
8. ceramic spray booth
9. kiln
10. potters wheel
11. electric range top with self-clean oven above
12. cabinet under/over
13. rotational molder
14. refrigerator
15. injection molder
16. compression molder
17. vacuum former
18. buffer
19. workbench
20. arc welding booth
21. oxy-ace booth
22. oxy-ace storage
23. welding vapor control
24. grinder
25. quency tank
26. soldering furnacd
27. molders bench
28. foundry
29. forge
30. spot welder
31. metals drill press
32. milling machine
33. metal lathe
34. wood lathe (one with profile attachment)
35. study carrel
36. washup
37. belt/disc sander
38. wood band saw
39. jig saw
40. jointer
41. circular saw
42. wood/plastic drill press
43. radial arm saw
44. shaper
45. metals band saw
46. panel saw
47. compressor
48. dust control
49. notcher
50. box and pan brave
51. rower
52. anvil stand
53. bar hold
54. stake plate
55. punch press
56. sp. shear
57. diazo bender
58. chalkboard and projection screen
59. bulletin board

MATERIAL ANALYSIS
&
PROCESSING SYSTEMS

A 9th and/or 10th grade Industrial
Education Curriculum designed to fulfil
the Kansas State Department of Vocational
Education's Level II course requirements.

•••EDITED BY HARVEY DEAN, S.E.T. PROJECT DIRECTOR•••

SET
PROJECT

DEVELOPMENTS OF THE
1972 and 1973 SUMMER WORKSHOPS
ESEA TITLE III PROJECT
26-70-1003
STATE OF KANSAS
INDEPENDENCE–BURLINGTON–SHAWNEE MISSION

IF YOU SHOULD HAVE QUESTIONS, COMMENTS OR REQUESTS
PERTAINING TO THIS CURRICULUM PLEASE CONTACT:

DIRECTOR, S.E.T. PROJECT
KANSAS STATE COLLEGE
PITTSBURG, KANSAS 66762

PREFACE

The Secondary Exploration Technology document, **MATERIAL ANALYSIS and PROCESSING SYSTEMS**, represents a cooperative effort between the Kansas School districts of Independence, Burlington, Shawnee Mission, and KSCP. It further represents a summer of initial trial development by ten (10) S.E.T. teachers with guidance from the S.E.T. Project Staff, a year of trial implementation in the three school districts and a final summer of revision and synthesis by project teachers and staff.

The S.E.T. Project Curriculum seeks to provide the teacher with the objectives, equipment lists, material, supplies, references, and activities necessary to teach students. Career information and the sociological implications of Material Analysis and Processing Systems is also included in activity form.

The user of this guide should recognize that activities to encompass the entire body of knowledge as depicted on page three are not included. It is impossible to teach in one semester, one year, or in one program the intracacies of the total body of knowledge. It is possible to teach the concepts of how Material Analysis and Processing Systems interrelate.

The credit for the content in this guide goes to the S.E.T. Teachers who developed, tried, revised and synthesized this curriculum. The curriculum should prove successful in other schools because of the practical and realistic activities delineated by the teachers.

The Teachers chose the equipment as listed in order that students could successfully complete given activities and meet specified objectives.

Other similar equipment may be available to complete given activities. It is not the purpose of this document to endorse educational equipment but merely to note equipment which proved successful in meeting the listed objectives for specific activities.

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Chairmen of 1972 Summer Trial Guide development

Robert Moore
Shawnee Mission Northwest High
Shawnee Mission, Kansas

Robert Dennis
Trailridge Jr. High
Shawnee Mission, Kansas

Coordinator Synthesizing document during
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Don Blazek
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Teachers who helped in the development of the Trial Guide, who taught from the trial guide and who helped during the synthesis of the guide:

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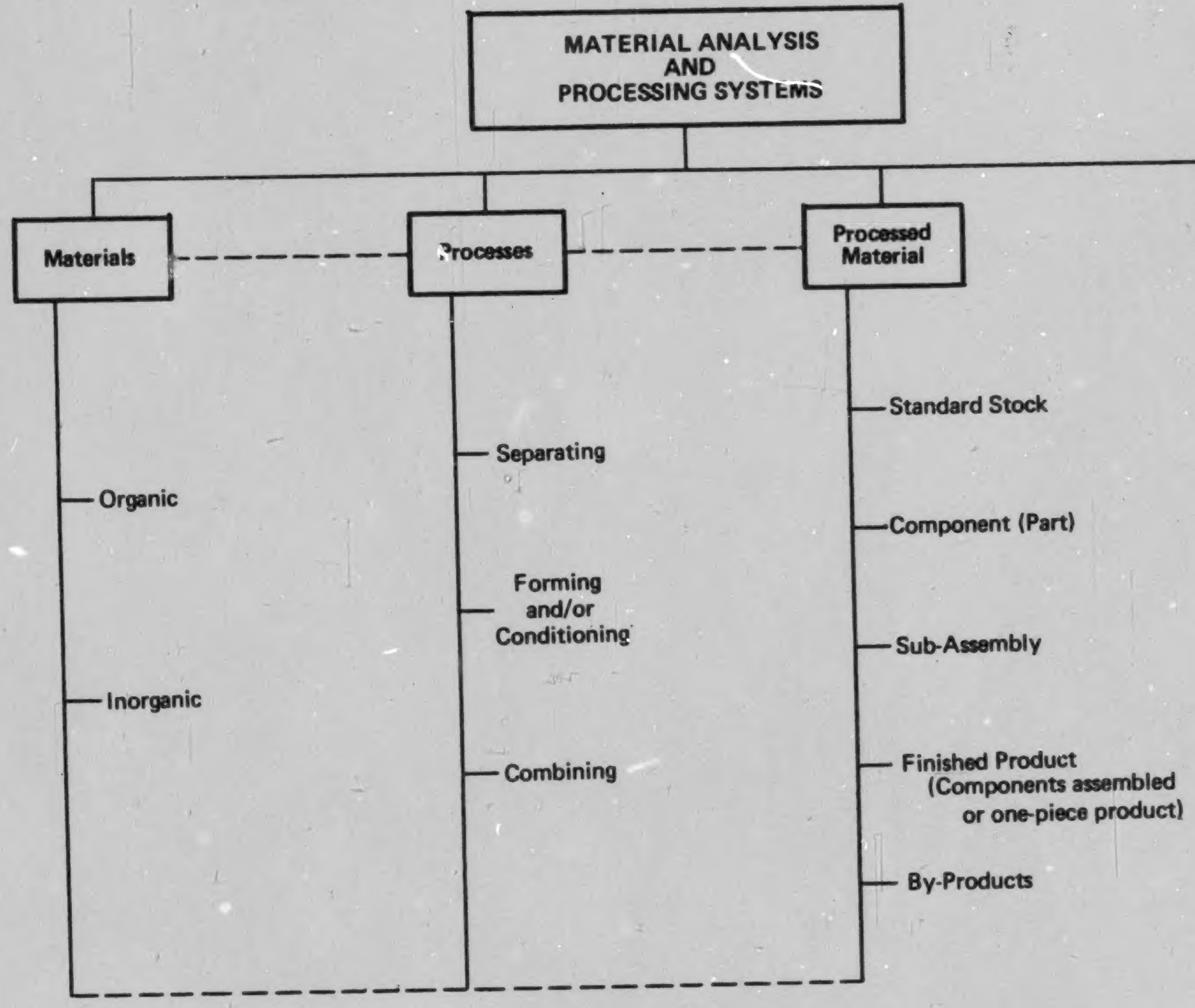
Harvey Dean, Director
F.V. Sullivan, Project
Consultant

RATIONALE

In recent years, rapid technological development of new materials and new methods of processing materials has greatly affected society. The larger percent of the societal changes have been of in a positive direction.

However, this rapid technological advancement mandates that education programs change so that school youth become aware of the technological world around them. Industrial education programs must capitalize on the students' interest in doing things by exposing him to materials and processes used in today's industry.

Definition of Material Analysis & Processing Systems: The study of organic and inorganic materials and how they are changed to satisfy man's material needs.


MATERIAL ANALYSIS AND PROCESSING SYSTEMS
Materials
Processes
Processed Material
Related Careers
Organic
Inorganic
Separating
Forming and/or Conditioning
Combining
Standard Stock
Component (Part)
Sub-Assembly
Finished Product (Components assembled or one-piece product)
By-Products

GOALS OF MATERIAL ANALYSIS AND PROCESSING SYSTEMS

1. To develop understanding and knowledge of the properties and characteristics of all materials.
2. To develop understanding and knowledge of the systematic processes involved in changing materials.
3. To provide opportunities for attaining knowledge of vocations and avocations within the area of material analysis and processing systems.
4. To provide insight into the socio-economical and/or environmental impact of industrial processing.
5. To develop desirable attitudes and practices with respect to industrial safety standards and efficient work habits.
6. To develop knowledge, experience and understanding of the relationship between material analysis and processing systems as related to other disciplines, curriculum areas, and industry.

MATERIAL ANALYSIS AND PROCESSING SYSTEMS

ACTIVITY OBJECTIVES

Upon completion of the material analysis and processing systems course:

1. The student will have participated in activities involved in changing materials by any combination of separating, forming, and/or conditioning, and combining processes as evidenced by the teacher's record of the completed activities within the designated time.
2. The student will have participated in activities involved in determining properties and characteristics of materials as evidenced by the teacher's record of the completed activities within the designated time.
3. The student will have participated in activities relating to safety standards and efficient work habits as evidenced by the teacher's record of the students completion of activities within the designated time.
4. The student will have participated in orientation and discussions of vocations and avocations relating to materials and processes as evidenced by the teacher's record of the completion of a pre-test/post-test within a designated time.
5. The student will have an opportunity to develop an insight into the socio-economical and environmental impact of industrial processing as evidenced by the teacher's records of the completion of prescribed activities within the designated time.

S.E.T. Project Material Analysis and Processing Systems Curriculum

PERFORMANCE OBJECTIVES

The performance objectives listed below should provide realistic attainment levels for students enrolled in the material analysis and processing systems course described in this guide. Each teacher may wish to establish his own performance levels for the course rather than use those indicated below. However, the test instruments included in Appendix   should prove valuable regardless of teacher choice.

Performance levels are not established for the activities delineated in this guide. Each teacher using this guide is encouraged to establish performance levels for his own class per activity and to build in his own evaluation criteria.

Definitions of Performance Objectives in the Psychomotor, Affective, and Cognitive domains are included in Appendix A.

Cognitive Performance Objective

Upon exiting the S.E.T. Project Material Analysis and Processing Systems course, the students will indicate a knowledge of Material Analysis and Processing Systems as evidenced by a significant increase of 20% in mean score between pre- and post-testing on the S.E.T. Project Material Analysis and Processing Systems Curriculum test.

Affective Performance Objective

Upon exiting the S.E.T. Project Material Analysis and Processing Systems course, the students will indicate the value of the study of Material Analysis and Processing Systems as evidenced by a 15% increase in the mean score between the S.E.T. Project pre-attitude inventory and the post-attitude inventory.

Psychomotor Performance Objective

During the Material Analysis and Processing Systems course the student will perform psychomotor skills in at least the imitation and/or manipulation level as evidenced by the teachers records of successful completion of at least eight of ten teacher selected activities that suggest these levels of skill development.

CONTENT OUTLINE FOR
MATERIAL ANALYSIS AND PROCESSING SYSTEMS

Recommended Days	Activity
3	I. **ORIENTATION** A. Give pre-test to all students B. Discuss general rules, lab procedures and policies C. Introduction to General Safety D. Introduction to Industrial Technology
1	II. **ANALYSIS OF INDUSTRIAL PRODUCTS** A. Material(s) used B. Process(es) used
1	III. **INTRODUCTION TO MATERIALS** A. General Properties and Characteristics of all materials 1. Inorganic materials 2. Organic materials
5	IV. **INTRODUCTION TO PROCESSES** A. Separating processes of material B. Forming and/or conditioning of material C. Combining process of materials
14	V. **SAFETY EDUCATION AND DEMONSTRATIONS OF EQUIPMENT** A. Conduct safety demonstrations on all machines and equipment B. Administer written and proficiency test for machines and equipment C. Provide students with machine demonstration check list D. Permit forms sent home to parents
50	VI. **TEAM ACTIVITIES** A. Delineated activities using various materials and processes
15	VII. **STUDENT CONTRACT WORK** A. Each student will work on area of interest. Contract filled out by each student.
1	VIII. **CONCLUSION** A. Give post-tests to all students

90 Total Days NOTE: **The S.E.T. curriculum is designed so that school's offering full year programs may expand this document without interrupting activity continuity. Many activities are included in Section VI specifically for this purpose.**

SECTION I.

ORIENTATION

DAY 1:

Provide all students with an answer sheet form and a copy of the pre-tests. (See Appendixs C & D). Have each student fill out all required information on the answer sheet form. Instruct the students that the test is to find out what they already know about material analysis and processing systems of industry.

DAY 2:

Provide all students with general rules and lab procedures and policies that they need to know and follow during the course of the year. The following is a suggested list of information that should be discussed.

1. Grading system
2. Storage of materials
3. Locker assignment
4. Seating arrangement
5. Discuss the cost of materials
6. Clean-up procedures
7. Provide students with a handout of course information and objectives
8. Policies of make-up work, absences, tardy permits, fire drills, passes from class, etc.

Discussion of general safety rules that need to be observed during the course. This can be done either by a handout list of general safety rules, films, filmstrips, or transparencies. At the completion of the period, provide a general safety test on material covered during the period.

DAY 3:

Lecture and discussion on introduction to Industrial Technology. Relate modern industry to the study of material analysis and processing systems. Define Modern Industrial Technology as "the doing of something in the most efficient and practical way in the production of a finished product." Inform the students that they will be studying industry by completing activities that involve various materials (example--wood, metal, plastic, ceramics, rubber, etc.) and material processing. Emphasize that there may be many ways to make a product but the intended utilization of the product dictates the material uses and the processing system used.

SECTION II.

ANALYSIS OF INDUSTRIAL PRODUCTS

DAY 4:

The instructor should select a few everyday products (examples: briefcase, tennis racket, motorcycle, car, etc.). Start the period by having the students list the names of various materials that can be found in a finished product. Also, have the student describe how they think the product was made and the processes that were performed in the fabrication of the product.

The rest of the period should be spent on discussion of the products and the materials and processes used. The students can then compare what they wrote on their paper and what was discussed during the class.

SECTION III.

INTRODUCTION TO MATERIAL ANALYSIS

DAY 5:

Begin the class period with a lecture/discussion on the general properties and characteristics of all materials. Explain the terms inorganic material and organic material. (See Definition of Terms, Appendix B) Spend some time with a short demonstration by using a piece of sheet metal, wood, and styrene plastic to show the relationship of the materials and explain the general working characteristics of each. Bend the piece of wood, sheet metal, and styrene plastic to illustrate the flex strength. Materials may have chemical, environmental, thermal, electrical, optical and mechanical characteristics. Discuss characteristics of each material.

DAYS 6 - 10: INTRODUCTION TO PROCESSING SYSTEMS

Begin with a lecture/discussion of processes. Use the catagories of processes (as listed) and provide a handout of this information to all students. You may wish to make transparencies of the processes and use this for lecture and discussion. Demonstrate how all materials can be processed in similar ways. Example: Use a piece of paper and illustrate how it can be separated, formed, and combined. Relate this information to all materials. Spend the next couple of days on demonstration that last only a few minutes just to show students the relationship of processes on various materials.

SECTION IV

RELATED INFORMATION

CATEGORIES OF PROCESSES

I. FORMING AND CONDITIONING

1. Peening
2. Rolling
3. Drawing
4. Pressing
5. Forging
6. Pressing or Stamping
7. Bending
8. Extruding
9. Spinning
10. Molding
11. Vacuum Forming
12. Curing
13. Crystallizing
14. Casting
15. Heat treating
16. Melting
17. Freezing
18. Winding
19. Post-Processing (altering, installing, maintaining, repairing)

II. COMBINING

A. Mixing
   1. Beating (stirring)
   2. Agitation
   3. Atomitization

B. Finish Coating
   1. Spraying
   2. Brushing
   3. Rolling
   4. Dipping
   5. Printing
   6. Dyeing
   7. Calendar coating
   8. Electrodeposition
   9. Oxidcoating
   10. Enameling

C. Assembling
  1. Procruement (General overview of how to get material to point of need)
  2. Fastening
    a. laminating
    b. felting
    c. welding
    d. brazing and soldering
    e. pinning
    f. shrinking
    g. pressing
    h. bonding
    i. typing

III. SEPARATING

1. Screening
2. Floating
3. Filtering
4. Magnetizing
5. Evaporating
6. Drying
7. Absorbing
8. Crushing
9. Milling
10. Turning (lathe, screw machine, chuck machine)
11. Shaping
12. Planing
13. Drilling
14. Boring
15. Broaching
16. Sawing
17. Abrading
    a. precision grinding
    b. non-precision grinding
    c. finishing
18. Shearing
19. Etching
20. Burning
21. Punching

SECTION V

SAFETY EDUCATION AND EQUIPMENT DEMONSTRATIONS

DAYS 11-24:

Safety education is a major facet of the instructional program in industrial education. It is apparent that the industrial education teacher not only has the responsibility for giving instructions on the operation of all the machines used during the material analysis and processing systems course, but also for the development of an overall safety program for his students.

The S.E.T. Teachers recommend that in order to organize the safety program and to carry it out, the instructor must provide the following:

1. Safety demonstrations for all machines
2. Written safety test
3. Safety rules provided for general safety, machines, hand tools, etc.
4. Eye protection
5. Safety file kept for all students
6. Posters and charts
7. Visual aid resources
8. Safety permit forms (Appendix H)
9. Safety instruction form (Appendix I)
10. Proficiency test on operation of machines, equipment

A good safety program means more than the formulation and enforcement of a set of safety rules. It means that the student must have a safe environment in which to work, that safe practices must be an integral part of the training, that constant supervision must be provided. It is the responsibility of the individual teacher to organize his own safety program for the course using the required information provided in this guide. If this is provided, it will benefit not only the teacher but also the student.

SECTION VI

INDIVIDUAL AND/OR GROUP ACTIVITIES

DAYS 25-74:

It will be the instructor's responsibility to organize and plan student activities selected from this guide. Although all the activities provided in this guide cannot be covered in the short length of time, it is up to the individual teacher to carefully select those activities that can be covered using materials and equipment on hand. The information provided on the following activities provide the instructor with the name of the activity, material and processes covered, reference materials needed, and other information necessary to complete the activity. Some of the activities will require a teacher demonstration before a student can perform the particular activity. This decision will have to be made by the individual teacher.

One method of completing the included activities is to establish a specific number of days for the metal process activities, a specific number of days for the wood activities, etc. Another method would be to select all combining activities and specify the number of days required to complete the activities. The same procedure could be followed with the forming, separating, and conditioning processes. However, the final decision will be left up to the teacher using this guide.

At the completion of each activity, the student should complete the Process Evaluation Form (Appendix J). The student presents the form to the instructor for final evaluation of the completed activity.

It may prove advantageous to allow two students to work together on each activity. The team approach allows the students to help each other as they complete the activity. The approach also proves helpful when one student is absent from school, and as a result, misses a demonstration. The non-absent student can relate the demonstration to his partner thereby allowing him to complete the activity.

PROCESS: FORMING AND/OR SEPARATING
MATERIAL: PLASTIC

ACTIVITY
"Testing Plastic Characteristics"

Allow 1 class period

OBJECTIVE: At the conclusion of this activity the student will be able to identify a minimum of ten types of plastics as evidenced by successfully completing the form provided.

EQUIPMENT AND SUPPLIES NEEDED: Matches, soldering iron, test tubes, test tube stand, plastic sample strips ½" x 5"

REFERENCE MATERIAL: PLASTIK-LAB—Student Workbook

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material on properties and characteristics of plastics.
   - B. Provide each student with an answer sheet form (see Figure B included)
2. Teacher Demonstration
   - A. Using pre-selected samples of thermo-set material and thermo-plastic material demonstrate the procedure which should be followed in the various tests of material.
3. Student Activity
   - A. Identify 10 pieces of plastic material by following the procedure list and information presented by the instructor.

PROPERTIES AND CHARACTERISTICS OF VARIOUS PLASTICS

(c) Plastik/Labs, Wichita, Kansas

IDENTIFYING PLASTICS

Plastics may be identified by a number of different tests. One's knowledge of resins and their particular application can be used as a basis for identifying a resin. Feel, smell and sight may also give a person an indication of a certain plastic. Certain solvent tests can be performed on unknown plastics to help in identifying them. Measuring the specific gravity of a plastic will also aid in identifying the item. These tests, however, will give only an indication as to the correct identity. Infrared spectroscopy is the only accurate method of identifying an unknown plastic resin. X-ray emission determines the individual elements composing the sample.

The "match test" is one of the best simple tests to determine the type of an unknown plastic. The test involves holding a flame under the unknown plastic and observing if the material burns, color of the flame, any smoke present, odor given off, any dripping of the material and if the material will continue to burn if the flame is removed. This simple test is the most reliable test with the exception of infrared spectroscopy.

THE MATCH TEST

The chart in figure A has been provided to help you identify the sample's burning characteristics. When you have identified a sample, place the correct name in the chart in figure B. The plastic material should have a code number on it. Place the code number opposite of the name of the plastic material.

STEP 1. Select a sample.

STEP 2. Using a soldering iron, see if the sample will melt. A thermoset plastic will not melt, but a thermoplastic will.

STEP 3. When the sample has been identified as either thermoplastic or thermoset, you will be able to proceed on to either the right columm or the left column of the chart in figure A.

STEP 4. Strike a match to determine whether the material will burn or not burn. Whether it burns or not determines which column on the chart you must follow.

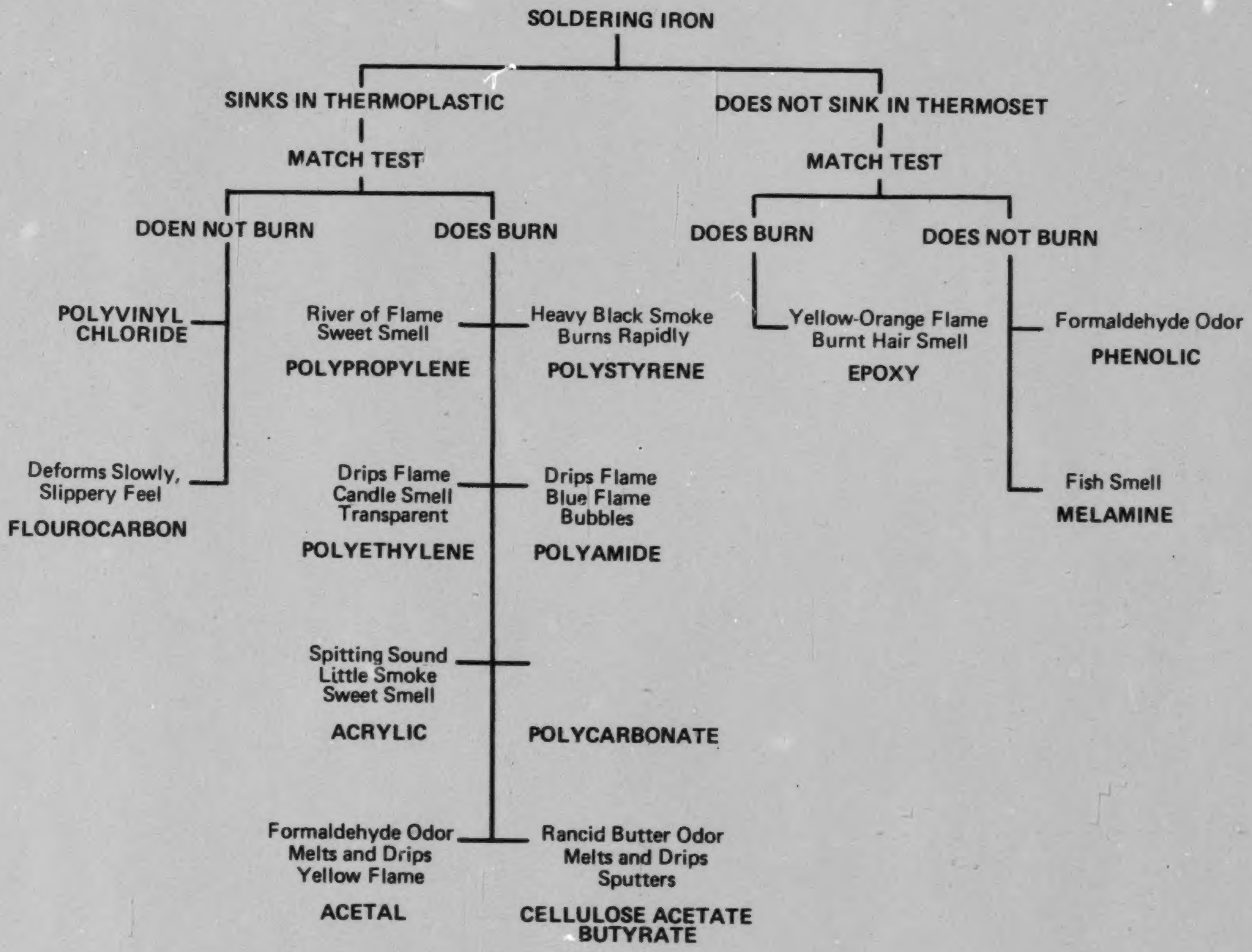
STEP 5. Observe the burning characteristics and determine the unknown sample's correct name.

(c) Plastik/Labs, Wichita, Kansas

STEP 6. Perform the same test on each of the 13 samples. USE CAUTION WHEN BURNING A PIECE OF PLASTIC.

As an example, let's take the plastic, polyester. When we apply the soldering iron to polyester, it does not melt. This indicates that it is a thermoset and we must use the chart to the right. When a burning match is placed under the sample, the material burns. This means that we must follow the column "does burn." The characteristics of polyester are that it ignites rapidly, black carbon is given off, a sweet odor is given off and the resin is self-extinguishing when the flame is removed. Keep in mind that there are many other plastic resins that can be identified by burning. The chart shows only the most common resins.

(c) Plastik/Labs, Wichita, Kansas


SOLDERING IRON
SINKS IN THERMOPLASTIC
DOES NOT SINK IN THERMOSET
MATCH TEST
MATCH TEST
DOEN NOT BURN
DOES BURN
DOES BURN
DOES NOT BURN
POLYVINYL CHLORIDE
River of Flame Sweet Smell
POLYPROPYLENE
Heavy Black Smoke Burns Rapidly
POLYSTYRENE
Yellow-Orange Flame Burnt Hair Smell
EPOXY
Formaldehyde Odor
PHENOLIC
Deforms Slowly, Slippery Feel
FLOUROCARBON
Drips Flame Candle Smell Transparent
POLYETHYLENE
Drips Flame Blue Flame Bubbles
POLYAMIDE
Fish Smell
MELAMINE
Spitting Sound Little Smoke Sweet Smell
ACRYLIC
POLYCARBONATE
Formaldehyde Odor Melts and Drips Yellow Flame
ACETAL
Rancid Butter Odor Melts and Drips Sputters
CELLULOSE ACETATE BUTYRATE

(c) Plastik/Labs, Wichita, Kansas

Figure B

SAMPLE	RESIN NAME
A	
B	
C	
D	
E	
F	
G	
H	
I	
J	
K	
L	
M	

PROCESS: SEPARATING, FORMING,
COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Classifying Material"

Allow 1 class period

OBJECTIVE: The student will demonstrate his knowledge of the two classifications of plastic materials by completing the assignment sheet on various plastics, their classification, properties, and applications.

EQUIPMENT AND SUPPLIES NEEDED: Acrylic sheet, phenolic formed coaster, matches, overhead projector

REFERENCE MATERIAL: THE STORY OF THE PLASTICS INDUSTRY, pages 6-7, Plastics: What Are They?
Also: Definitions on page 6
Use transparencies, included, on Plastic Structure, Thermosetting and thermoplastic.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   A. Review the reference material on the classification of plastic.

2. Teacher Demonstration
   A. Using a match, heat a piece of phenolic (coaster) and a piece of acrylic.

   B. Ask why one becomes flexible and one does not.

   C. Using the transparencies (as included), explain thermo-set and thermo-plastic. Discuss the basic structure of each.

3. Student Activity
   A. Complete the assignment sheet (as included).

THE STORY OF THE PLASTIC INDUSTRY, pages 6-7

Plastics: What They Are

Plastics are man-made materials, in contrast to nature's materials like wood and metal. A generally accepted definition is: Any one of a large and varied group of materials consisting wholly or in part of combinations of carbon with oxygen, hydrogen, nitrogen and other organic and inorganic elements which, while solid in the finished state, at some stage in its manufacture is made liquid, and thus capable of being formed into various shapes, most usually through the application, either singly or together, of heat and pressure.

Plastics are a family of materials--not a single material--each member of which has its special advantages.

Being man-made, plastic raw materials are capable of being variously combined to give most any property desired in an end product. But these are controlled variations unlike those of nature's products.

The widespread and growing use of plastics in almost every phase of modern living can be credited in large part to their unique combinations of advantages. These advantages are light weight, range of color, good physical properties, adaptability to mass-production methods and, often, lower cost. Some plastics can be sterilized.

Aside from the range of uses attributable to the special qualities of different plastics, these materials achieve still greater variety through the many forms in which they can be produced.

They may be made into definite shapes like dinnerware and electric switchboxes.

They may be made into flexible film and sheeting familiar as shower curtains and upholstery.

They may be made into sheets, rods and tubes that are later shaped or machined into internally-lighted signs, airplane blisters.

They may be made into filaments for use in household screening, industrial strainers and sieves.

They may be made into netting in a variety of patterns and sizes.

They may be used as a coating on textiles and paper.

They may be used to bind together such materials as fibers of glass and sheets of paper or wood to form boat hulls, airplane wing tips and table tops.

They may be used as adhesives, and in lacquers and paints--uses which are but mentioned in this booklet which deals specifically with solid forms of plastics.

Whatever their properties or form, plastics all fall into one of two groups--the *thermoplastic* or the *thermosetting.*

Definitions:

Thermoplastic:

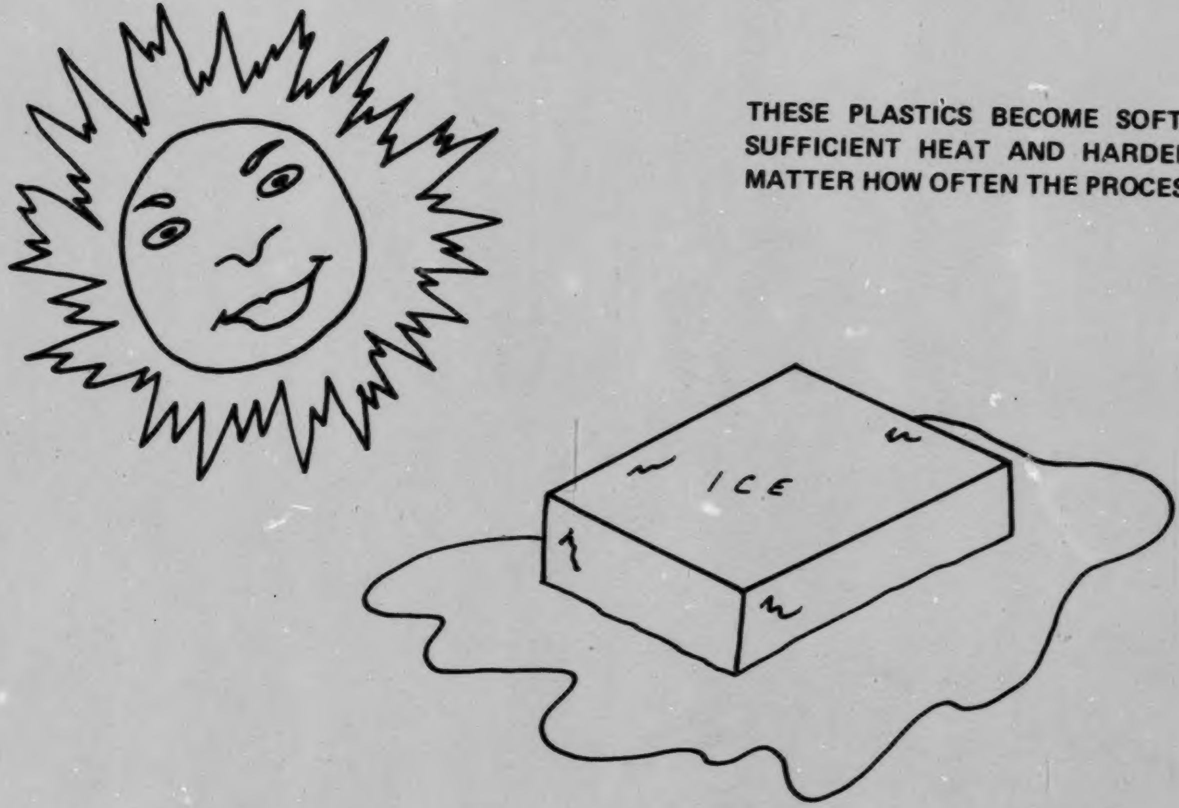
These plastics become soft when exposed to sufficient heat and harden when cooled, no matter how often the process is repeated. In this group fall ABS (acrylonitrile-butadiene-styrene), Acetal, Acrylic, the cellulosics, ethylene-vinyl acetate, fluorocarbon, ionomer, nylon, parylene, phenoxy, polyallomer, polycarbonate, polyethylene, polyphenyl oxide, polyimide, polypropylene, polystyrene, polysulfone, urethane. and vinyl.

Thermosetting:

The plastics materials belonging to this group are set into permanent shape when heat and pressure are applied to them during forming. Reheating will not soften these materials. Thermosetting plastics include: alkyd, amino (melamine and urea), casein, cold molded, epoxy, phenolic, polyester, and silicone.

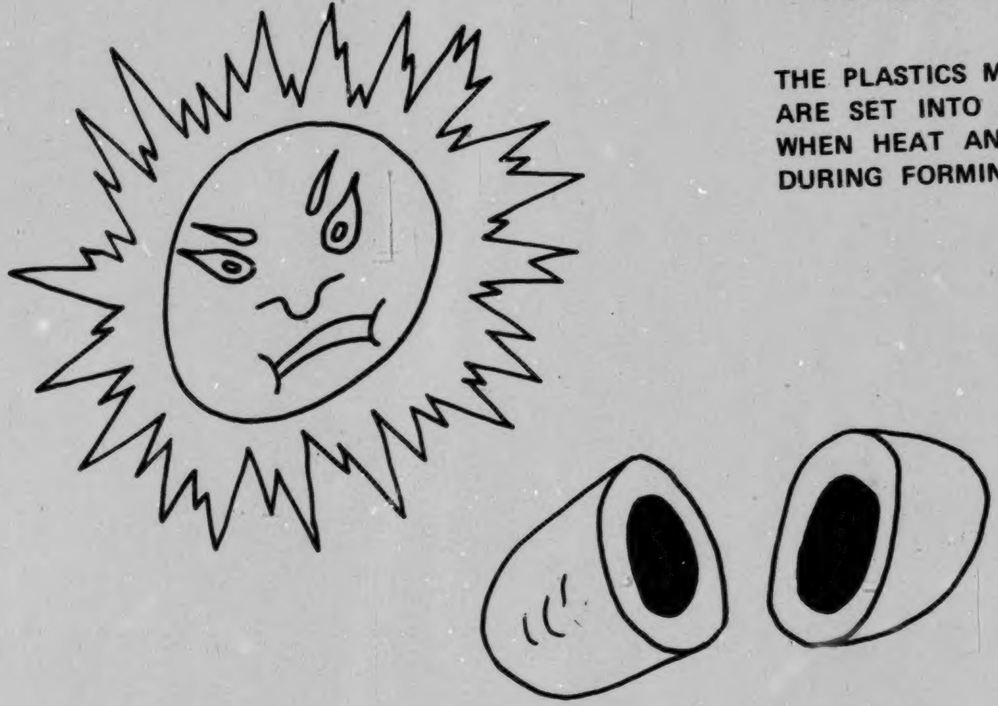
THERMOPLASTIC

THESE PLASTICS BECOME SOFT WHEN EXPOSED TO SUFFICIENT HEAT AND HARDEN WHEN COOLED, NO MATTER HOW OFTEN THE PROCESS IS REPEATED.

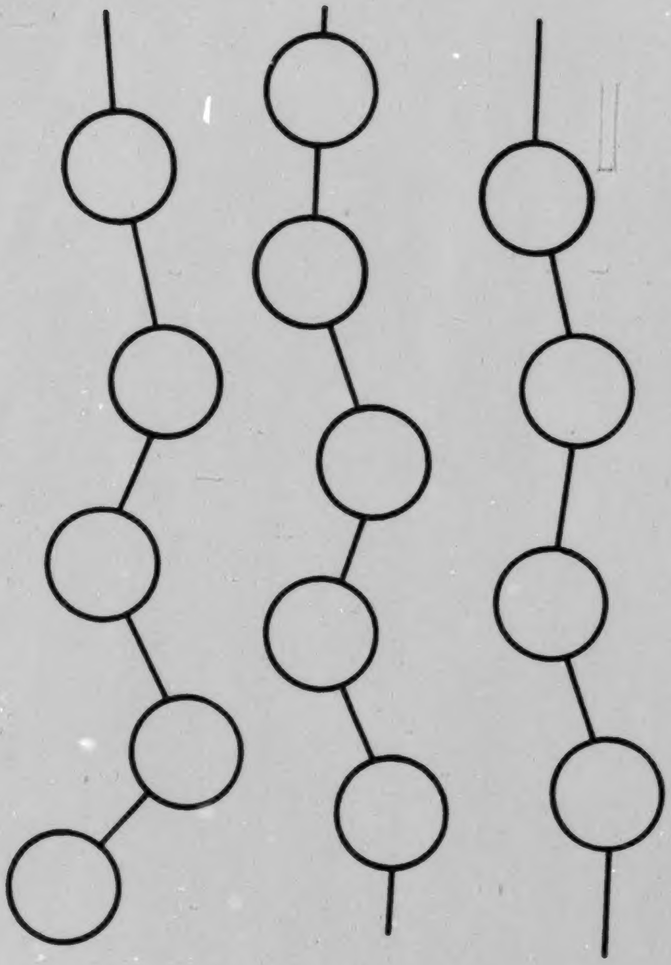


THERMOSETTING

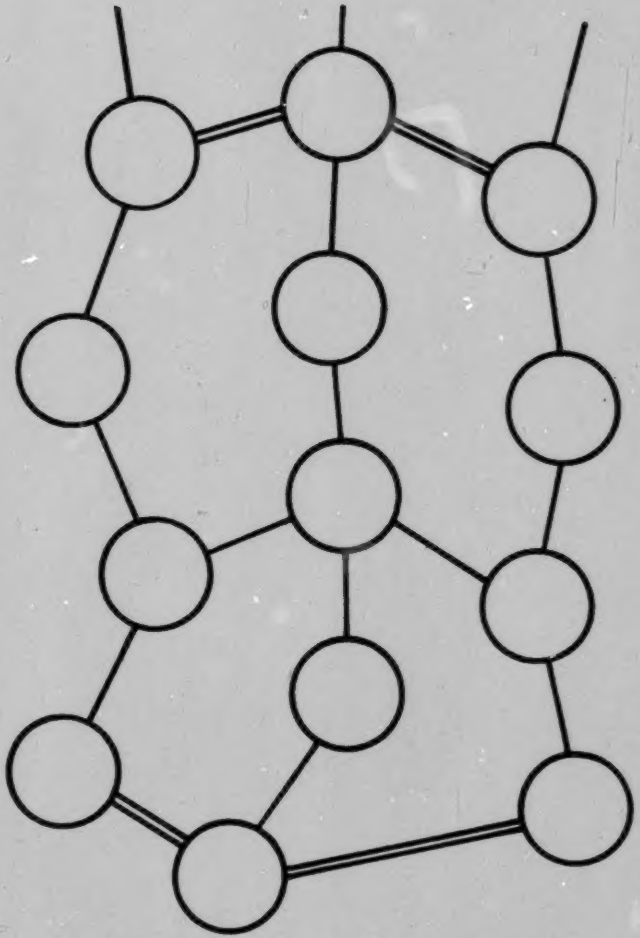
THE PLASTICS MATERIAL BELONGING TO THIS GROUP ARE SET INTO PERMANENT (USUALLY RIGID) SHAPE WHEN HEAT AND PRESSURE ARE APPLIED TO THEM DURING FORMING.



PLASTIC STRUCTURE



THERMOPLASTIC



THERMOSETS

BEST COPY AVAILABLE

RESIN	THERMOSET OR THERMOPLASTIC	SPECIAL PROPERTIES	APPLICATIONS
Polyester		1. 2.	1. 2.
Polystyrene		1. 2.	1. 2.
Fluorocarbon		1. 2.	1. 2.
Epoxy		1. 2.	1. 2.
Polycarbonate		1. 2.	1. 2.
Polyethylene		1. 2.	1. 2.
Phenolic		1. 2.	1. 2.
Acetal		1. 2.	1. 2.
Cellulosics		1. 2.	1. 2.
Vinyl		1. 2.	1. 2.
Polyurethane		1. 2.	1. 2.
Polypropylene		1. 2.	1. 2.
Polyamide		1. 2.	1. 2.
Acrylic		1. 2.	1. 2.
Melamine		1. 2.	1. 2.

PROCESS: SEPARATING AND FORMING
MATERIAL: PLASTICS

ACTIVITY
"Pressing Acrylic Plastic"

Allow 2 class periods

OBJECTIVE: At the completion of the activity the student will demonstrate his knowledge of the separating and forming processes by constructing a candy dish.

EQUIPMENT AND SUPPLIES NEEDED: Tools: File, file card, jig for forming dish. Supplies: 3/16" acrylic sheets 10" square, No. 320 wet and dry abrasive or equivalent, water, and paper cups. Equipment: band saw, belt and disc sander, buffer, oven

REFERENCE MATERIAL: INDUSTRIAL PLASTICS, pages 155-156, (up to Vacuum Forming)

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   A. Review the reference material.

   B. Discuss the process of forming material by using heat and pressure.

   C. Lay out 10" squares on a piece of 3/16" acrylic sheet and cut square on the circular saw or band saw.

   D. You should have prepared a plug and mold for the student activity.

2. Student Activity
   A. Layout a 10" circle and cut it out on the band saw.

   B. Sand off all edge marks caused by the saw by either using a belt or disc sander.

   C. File edges with file.

   D. Finish sand.

   E. Buff or polish.

   F. Heat the plastic in oven at 325 degrees for approximately 5 minutes.

   G. Take out of oven and place on the top of the jig. Use the mate part of the mold and press the piece into the jig.

   H. Form the dish by using hand to arrange the leaf parts the way you want.

   I. Let cool at room temperature.

   J. Repeat steps G, H, I if the design is not correct.

PROCESS: COMBINING & SEPARATING
MATERIAL: PLASTICS

ACTIVITY
"Laminating and Bonding"

Allow 2 class periods

OBJECTIVE: At the completion of the activity the student will demonstrate his knowledge of the separating and combining processes as evidenced by making a laminated name plate.

EQUIPMENT AND SUPPLIES NEEDED: Sand paper, engraving machine, sander, buffer

REFERENCE MATERIAL: INDUSTRIAL PLASTICS, page 261

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   A. Review the reference material

   B. Discuss the combining process

2. Teacher Demonstration
   A. Demonstrate the procedures to be followed (as listed in Student Activity).

3. Student Actitity
   A. Cut 1/16 x 4" x 8" acrylic pieces, 3 for each student. Use 2 colors of acrylics; one should be white.

   B. Laminate a white piece in the center of the other two. Use solvent cement.

   C. Allow to dry and then sand rough edges and buff.

   D. Select correct fonts and place into clamps on engraving machine.

   E. Enter engraving stock into clamp.

   F. Engrave name into stock.

   G. Make sure you go over each letter twice to insure correct depth of cut and width of cut.

   H. Remove engraving stock from machine.

PROCESS: SEPARATING, FORMING AND/OR CONDITIONING, COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Drilling, sawing, turning, cohension/adhesion"

Allow 5 class periods

OBJECTIVE: *At the conclusion of this activity the student will have a knowledge of separating and combining processes as evidenced by completing the designated product.*

EQUIPMENT AND SUPPLIES NEEDED: Sheet Acrylic, ¼" Rod.

REFERENCE MATERIAL: INDUSTRIAL PLASTICS, pages 221-225, 236-237, 234-235

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   A. Review the reference material.

   B. Discuss the combining process (adhesion/cohesion)

2. Teacher Demonstration
   A. Demonstrate the procedures to be followed (as listed in Student Activity)

3. Student Activity
   A. Cut out 4 pieces of acrylic 1" x 4" long.

   B. Laminate the pieces together using a solvent cement.

   C. Sand corners off or turn on the lathe.

   D. Drill hole in end ¼ D. (Hole should be smaller than ¼" steel rod).

   E. Make a screwdriver end on the ¼" rod.

   F. Freeze the screwdriver blade in an ice box for 24 hours.

   G. Heat screwdriver handle.

   H. Press the screwdriver blade into the hole in the acrylic plastic and let the temperatures neutralize.

PROCESS: SEPARATING, FORMING AND/OR CONDITIONING, COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Shaping and Dipping"

Allow 5 class periods

OBJECTIVE: At the completion of the activity, the student will demonstrate his knowledge of moldmaking and plastisol molding as evidenced by construction of a mold suitable for dip molding.

EQUIPMENT AND SUPPLIES NEEDED: Pliers, file, abrasive paper, aluminum for mold, IASCO dip molding Plastisol and color pigment, gloves, metalworking equipment, and an oven

REFERENCE MATERIAL:

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   A. A pocket coin purse is a very suitable mold for this activity.

   B. Review the reference material.

   C. Discuss the process with the students.

2. Student Activity
   A. Design and construct an aluminum mold for dip molding plastisol.

   B. Test the mold by carrying out the complete molding process.

   C. Dip the mold in plastisol and cure in oven.

   D. Test the different ranges of temperature of the mold and its effect on the coating process of plastisol.

PROCESS: CONDITIONING, FORMING,
AND COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Casting in RTV Silicone Rubber Molds"

Allow 2 class periods

OBJECTIVE: At the conclusion of this activity the student will be able to cast liquid plastisol in RTV silicone rubber molds as evidenced by completion of products.

EQUIPMENT AND SUPPLIES NEEDED: "Casting in Silicone Rubber Molds" Teaching Unit by PITSCO, Box 26,
Pittsburg, KS 66762

REFERENCE MATERIAL: CASTING IN SILICONE RUBBER MOLDS, by PITSCO

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   A. Review reference material.

   B. Discuss RTV molds.

2. Student Activity
   A. Complete the assigned products by following the procedures listed in the manual.

(c) PITSCO, Inc., Pittsburg, Kansas

MOLDING PLASTIC
IN RTV SILICONE RUBBER MOLDS

During the past twelve years room temperature vulcanizing (RTV) Silicone Rubber has become a very popular raw material for fabricating molds. Industry has used the RTV molds to manufacture and fabricate thousands of consumer products.

RTV Silicone Rubber is highly flexible. It has great resistance at temperature changes, and is strong, resilient and stretchable to temperatures where organic rubber fails. It is moisture resistant, fire resistant and chemical resistant. It also provides better release from sticking than any other rubber.

The molds used to form the fishing lures in this unit are made of RTV Silicone Rubber.

The following applications are only a few of the many possible uses of RTV Silicone Rubber:

Automotive Industry

a. Hydraulic brake boots and cups

b. Hose
c. Clutch diaphragms

d. Seals

e. Spark plug boots

Aerospace Industry

RTV Silicone Rubber has played an important role in the voyages to the moon. From the launching of the Mercury spacecraft in 1961 to the successful Apollo flights, RTV Silicone Rubber has been widely used in spacecraft and in astronaut space suits. The first footprint on the moon was made by shoe soles made of RTV Silicone Rubber. A few of the uses in the Aerospace Industry Are:

a. Capsule air seal gaskets

b. Space suit gaskets

c. Wrist and elbow joints of Apollo suits

d. Finger caps of Apollo space suit gloves

e. Lunar overshoe soles

Appliance Industry

a. Seals, gaskets, and insulation in frying pans, steam irons, coffee makers, etc.

b. Oven door gaskets

Electrical Industry

a. Lineman protective devices

b. Television corona shields

c. Tubing and sleeving

d. Wire and cable insulation

Miscellaneous Uses

a. Baby bottle nipples

b. Conveyer belts

c. O-rings

d. Suction cups

The above listing is a very small representation of industrial uses of RTV Silicone Rubber.

No other mold material offers the precise reproduction of intricate detail which is possible with RTV Silicone Rubber molds. Many parts previously fabricated in expensive metal molds are currently made in RTV Silicone Rubber molds. RTV molds require no mold release due to their natural release capability. These factors provide quality molds at economical prices.

The furniture making industries use RTV Silicone Rubber molds to produce picture frames, furniture trim, mold, and decorative panels used on antique or period style furniture. The plastic solution used to form the furniture parts may be stained to match natural wood colors. The RTV molds produce small details to the extent that the molded plastic furniture parts show the original wood grain.

Many outdoorsmen are familiar with plastic fishing worms. The production of plastic worms is readily accomplished by heating a plastic solution and pouring it into RTV Silicone Rubber molds. The plastic worm industry alone accounts for millions of dollars in annual sales.

The following plan of procedure explains in detail the molding of plastic fishing worms using a plastic solution and RTV Silicone Rubber molds. One should recognize that the molding of plastic worms is in actuality a small example of a process used in industry. The potential use for RTV Silicone Rubber is unlimited.

PROCESS: FORMING AND CONDITIONING
MATERIAL: PLASTICS

ACTIVITY
"Drying and Expandable Bead Molding"

Allow 2 class periods

OBJECTIVE: The student will demonstrate his knowledge of expandable bead molding as evidenced by set-up of equipment and using polystyrene beads for the construction of a product.

EQUIPMENT AND SUPPLIES NEEDED: Polystyrene beads, bucket, wire strainer, thermos-jug mold, hot plate, pressure cooker.

REFERENCE MATERIAL: Film: PACKAGING WITH DYLITE
INDUSTRIAL PLASTICS, page 217-218
Film by Plastik-Lab, Koppers Co., Plastics Division, Koppers Building, Pittsburgh, PA 15219

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material.
   - B. Show film listed in reference material if time is available.
   - C. Show film or filmstrip by Plastik-Lab on Expandable Bead Molding.
   - D. Discuss drying and pre-expanding processes.
     1. Radiant heaters over a variable speed traveling belt
     2. Other type of heat source over a constant speed traveling belt.
2. Teacher Demonstration
   - A. Demonstrate the proper operation and procedure for expandable bead molding processes.
3. Student Activity
   Procedures to follow for expandable bead molding
   1. Expandable polystyrene beads are pre-expanded by placing them in boiling water, by using a radiant heater, or by using a heat gun with a pre-expansion unit.
   2. Apply mold release or paste wax to inside of thermos jug mold.
   3. Buff and polish the mold halfs and remove all excess paste wax.
   4. Pre-expand beads by using one of the methods described in step 1.
   5. Place 1 large mouth jar (1 qt.) inside mold.
   6. Fasten the mold halves together.
   7. Fill bottom half of the mold first.
   8. Place plug in the bottom of mold and turn it over so you can fill top.
   9. Fill top part of mold and clamp both plugs into place.

10. Place mold into pressure cooker and clamp lid into place.
11. Allow the pressure to build to 15lbs. Allow 12-15 minutes for expansion and fusion of the beads.
12. Remove safety valve cap to remove pressure.
13. Take lid off and allow mold to cool. Remove finished product.

PROCESS: SEPARATING AND FORMING
MATERIAL: PLASTICS

ACTIVITY
"Shearing and Vacuum Forming"

Allow 1 class period

OBJECTIVE: At the completion of the activity the student will demonstrate his knowledge of vacuum forming as evidenced by completing the product.

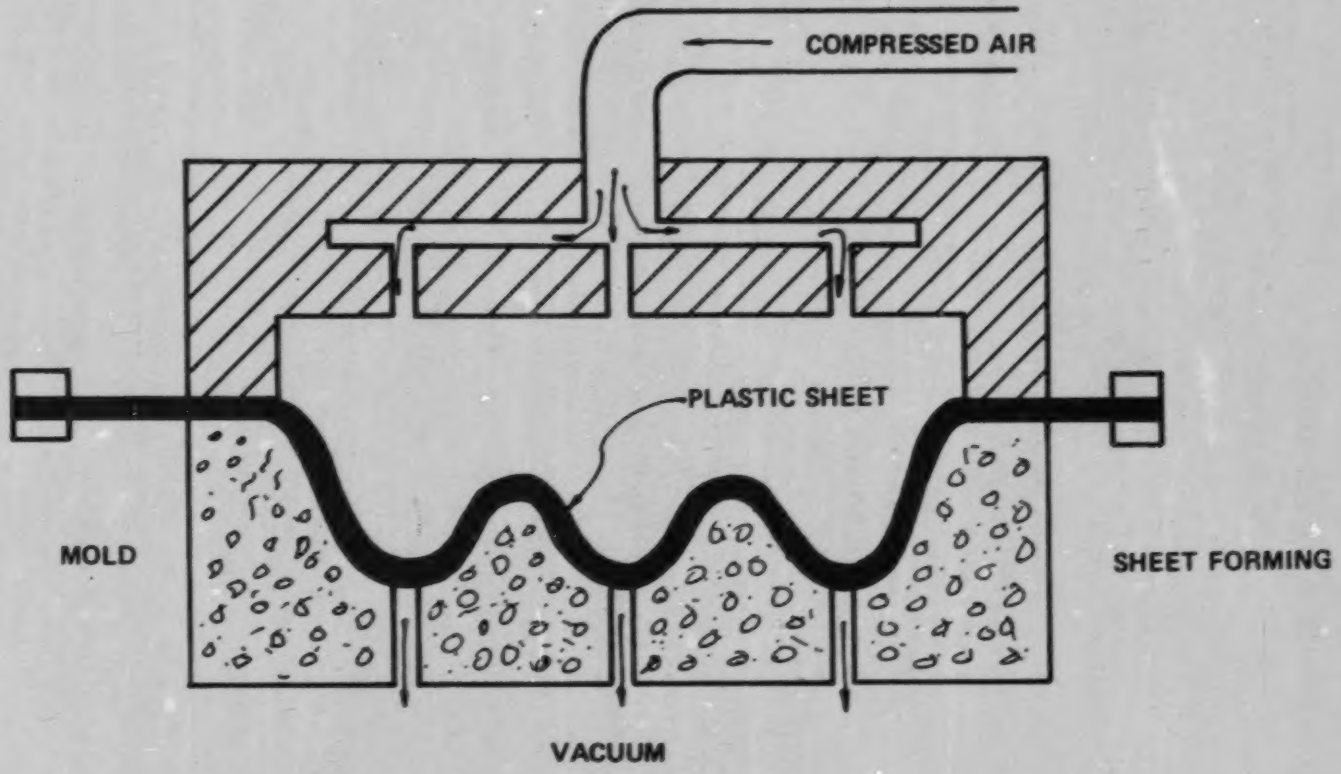
EQUIPMENT AND SUPPLIES NEEDED: Scissors or knife, 020 high impact styrene sheet, vacuum forming machine

REFERENCE MATERIAL: INDUSTRIAL PLASTICS, pages 156-158
Plastik-Lab Filmstrip

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material.
   - B. Show the filmstrip.
   - C. Discuss the vacuum forming process and its relation to industry. You may wish to use the transparency master included.
2. Teacher Demonstration
   - A. Demonstrate the procedures listed in Student Activity.
3. Student Activity
   - A. Place a sheet of high impact styrene in the machine and clamp.
   - B. Place the heating element over the sheet and switch the heat on.
   - C. Heat the sheet until you can see a small amount of smoke come off the sheet.
   - D. At that point, switch the vacuum on and pull the sheet down over the mold.
   - E. Remove formed sheet from the machine and let cool at room temperature.
   - F. Cut out desired form from the sheet with scissors or knife.
   - G. Sand edges if necessary.

THERMOFORMING


COMPRESSED AIR
PLASTIC SHEET
MOLD
SHEET FORMING
VACUUM

PROCESS: CONDITIONING AND FORMING
MATERIAL: PLASTICS

ACTIVITY
"Annealing (Heat Treating)"

Allow 1 class period

OBJECTIVE: At the completion of the activity, the student will demonstrate his knowledge of annealing as evidenced by successful completion of test items.

EQUIPMENT AND SUPPLIES NEEDED: Acrylic product or machined part, oven

REFERENCE MATERIAL: GENERAL PLASTICS, by Raymond Cherry, McKnight & McKnight, page 93 included

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   A. Review the reference material.

   B. Discuss the application and need for annealing.

2. Teacher Demonstration
   A. Demonstrate the process by selecting a part and completing the procedures listed in Student Activity.

3. Student Activity
   A. Anneal a piece by completing the procedures listed in the reference material.

by Cherry
(c) McKnight Publishing Company
Bloomington, Indiana

GENERAL PLASTICS--(projects and procedures)

Chapter 14 page 93

PROCEDURES

1. Remove all masking paper and coatings before annealing is done.
2. Be sure that the plastic is clean and dry.
3. Support the plastic in the oven so that it will not be under stress while it is being annealed.
4. Preliminary annealing is done before any cementing. This will eliminate stresses induced by the machining operations. If this stress is not removed, the cement may cause crazing. The annealing should be done not more than 24 hours prior to the cementing.
5. Final annealing is done after cemented joints have been in the clamps or jig for at least four hours. This will prevent crazing due to the solvent action of the cement on the plastic. If clamps are left on the assembly when it is placed in the oven, be sure that they are supported, because the weight of the clamps may set up local stresses. The strength of a cemented joint may be increased as much as 200 percent after annealing.
6. The annealing temperature should be 10° F. below the minimum temperature at which formed parts show deformation. Very little dimensional change takes place if Plexiglas II, G, and 55 are annealed at 175° F. At these temperatures the annealing time is about eleven hours. The temperature can be reduced if the time is increased. If annealed for 24 hours, the minimum annealing temperature is 160° F. for Plexiglas II and G; 175° F. for Plexiglas 55; and 120° F. for Plexiglas I-A. See Table 3.
7. The annealing temperature for parts that show no deformation may be increased to 230° F. for Plexiglas II and G, and to 195° F. for Plexiglas I-A. At these temperatures the annealing time for Plexiglas 1/16" thick will be two hours and for Plexiglas 1 ½" thick, four hours. See Table 3.
8. The cooling rate is much slower for thick than for thin material. After the heating period in annealing, the temperature of the oven should be reduced at a given rate with the plastic still in it. See the Rate column of Tabel 4.
9. The maximum removal temperature from the oven is 160° F. for Plexiglas II and G; 175° F. for Plexiglas 55; and 120° F. for Plexiglas I-A. Therefore, if the minimum annealing temperatures as given in Step 6 were used, the material could be carefully removed immediately after the heating time of the annealing period.
10. The maximum cooling rate for all four types of Plexiglas annealed in Step 7 would be 120° F. per hour for 1/16" material. At this rate it would take 45 minutes to cool. The temperature of the oven should be reduced only 13° F. per hour for Plexiglas 1 ½" thick. At this rate it would take 5 ¾ hours to cool down to the removal temperature. See Table 4.
11. For small work in craft classes, it will be necessary to check the cooling rate of the forming oven. The oven may have to be turned on from time to time if it cools too fast. Covering it with insulating material will slow the cooling rate.

PROCESS: ALL PROCESSES
MATERIAL: PLASTICS

ACTIVITY
"Film–Industrial Processes and Products"

Allow 1 class period

OBJECTIVE: After viewing the film the student will demonstrate his knowledge of plastic material and processes as evidenced by naming thirty items or more that are made from plastic material.

EQUIPMENT AND SUPPLIES NEEDED: 16mm film projector

REFERENCE MATERIAL: Film: Plastics: Industrial Processes and Products
The Society of the Plastics Industry, Inc.
250 Park Avenue, New York, New York 10017

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   A. Preview the film
   B. Introduce the film
2. Student Activity
   A. Have student write 30 or more different items that can be made from plastic material.

PROCESS: FORMING
MATERIAL: PLASTICS

ACTIVITY
"Curing, Spraying, and Brushing"

Allow 1 class period

OBJECTIVE: *At the completion of this film the student will have an understanding of reinforced plastics as evidenced by naming ten reinforced plastic products.*

EQUIPMENT AND SUPPLIES NEEDED: 16mm projector and screen

REFERENCE MATERIAL: Film: REINFORCED PLASTICS PROCESS
Verson Allsteel Press Co.
1355 East 93rd
Chicago, Ill. 60619

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
    - A. Preview the film.
    - B. Show the film
    - C. Have class discuss the film
2. Student Activity
    - A. Answer questions about the film in class discussion.
    - B. Name 10 reinforced plastic products.

PROCESS: FORMING
MATERIAL: PLASTICS

ACTIVITY
"Film–Injection Molding"

Allow 1 class period

OBJECTIVE: At the completion of this film the student will have an understanding of injection molding as it applies to industry as evidenced by participating in class discussion.

EQUIPMENT AND SUPPLIES NEEDED: 16mm projector and screen

REFERENCE MATERIAL: Film: AUTOMATIC RUNNERLESS INJECTION MOLDING
The Ross Milton Metals Co.
511 2nd St. Pike, Southampton, PA. 18966

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
    - A. Preview the film.
    - B. Show the film.
    - C. Have class discuss film.
2. Student Activity
    - A. Answer questions about the film in class discussion.
    - B. Understand waste, recycle, and granulation process.

PROCESS: COMBINING AND FORMING
MATERIAL: PLASTICS

ACTIVITY
RTV Silicon e Rubber Molds

Allow 2 class periods

OBJECTIVE: At the completion of this activity the student will have made an RTV Silicone Rubber mold as evidenced by the completed mold.

EQUIPMENT AND SUPPLIES NEEDED: RTV Silicone Rubber, catalyst for RTV, pattern, flask or form

REFERENCE MATERIAL:

PROCEDURE FOR THE ACTIVITY

1. Teacher Information

   A. RTV molds are widely used in industry to provide molds for intricately detailed objects.

   B. Request additional information on Silicone Rubber from Dow Chemical Co. and DuPont.

2. Teacher Demonstration

   A. Discuss the process

   B. Use a small object as a pattern.

   C. Place pattern in retaining flask or form.

   D. Prepare silicone RTV for pouring (add catalyst).

   E. Pour into one corner of flask allowing rubber to flow around the pattern.

   F. When pattern is ½ full stop pouring until the RTV rubber levels off.

   G. Resume pouring until the parts of the pattern are covered with a minimum of silicone rubber.

   H. Let mold set until firm.

   I. Carefully remove RTV mold and remove pattern.

3. Student Activity

   A. Allow each student to cast products by completing the procedures demonstrated.

PROCESS: COMBINING, FORMING,
SEPARATING
MATERIAL: PLASTICS

ACTIVITY
"Casting Plastic Resin"

Allow 2 class periods

OBJECTIVE: At the completion of this activity the student will demonstrate his knowledge of casting and curling as evidenced by forming a paper weight.

EQUIPMENT AND SUPPLIES NEEDED: File, file card, measuring cup, casting resin, hardener, wet & dry abrasive, glitter, mold, belt & disc sander, and buffer

REFERENCE MATERIAL: INDUSTRIAL PLASTICS, pages 175-176, Ronald Baird, Goodheart-Willcox Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material.
   - B. Discuss with the class the casting process and products made by casting.
2. Teacher Demonstration
   - A. Demonstrate the process by completing the following procedure:
     1. Select a mold such as a small wax coated paper cup.
     2. Measure out approximately 2 ounces of casting resin into a paper cup.
     3. Apply 6 drops of hardener to every ounce of resin.
     4. Mix resin and hardener and stir very slowly to avoid bubbles.
     5. Pour into mold and let gel for about 15 minutes. If you want an object inserted--place it in at this time.
     6. Pour the remaining resin on top of gel coat and object.
     7. Allow the casting to cure for about 24 hours at room temperature.
     8. Remove from mold. Use belt and disc sander and sand all edges.
     9. Finish sanding using No. 320 wet abrasive.
     10. Buff and polish.
     11. Be careful when buffing.
3. Student Activity-- Allow each student to cast resin and complete the product.

PROCESS: FORMING
MATERIAL: PLASTICS

ACTIVITY
"Extruding"

Allow 2 class periods

OBJECTIVE: At the completion of this activity the student will have a knowledge of forming plastic by extrusion as evidenced by successful completion of an objective test.

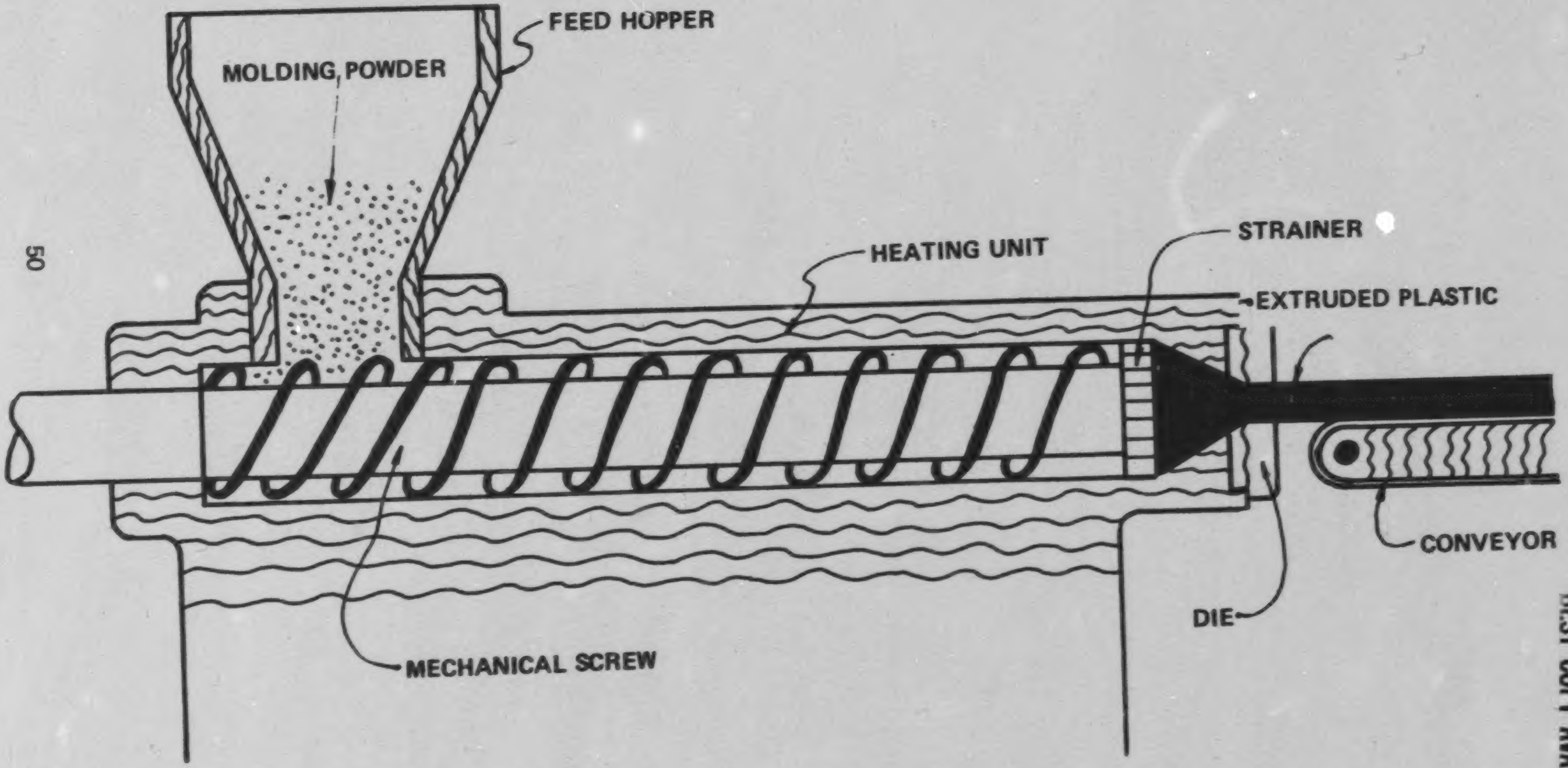
EQUIPMENT AND SUPPLIES NEEDED: Tooth paste tube, wall diagram of extrusion process, sample of extrusion products, sample of raw material (cake decorator)

REFERENCE MATERIAL: Films: EXTRUSION OF RIGID PVC PIPE FROM DRY BLEND, Prodex Div. The Koehring Co., King George Post RD., Foras, N.J. 08863
PIPE DREAMS COME TRUE, Uniroyal, Inc., Naugatuck, Conn. 06770
Transparency master on extrusion molding included

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
    - A. Preview the films.
    - B. Show the films.
2. Teacher Presentation
    - A. Compare the extrusion of tooth paste with the extrusion methods used in industry.
    - B. Discuss the types of dyes used.
    - C. Discuss materials adaptable to extrusion.
    - D. Relate the industrial and consumer application of extrusion.
    - E. Compare extrusion molding with injection molding.
3. Student Activity
    - A. Participate in discussion of extrusion.
    - B. Complete test on extrusion as presented by instructor.

EXTRUSION MOLDING


FEED HOPPER
MOLDING POWDER
HEATING UNIT
STRAINER
EXTRUDED PLASTIC
CONVEYOR
DIE
MECHANICAL SCREW

PROCESS: FORMING
MATERIAL: PLASTICS

ACTIVITY
"Slush Molding"

Allow 2 class periods

OBJECTIVE: At the completion of this activity the student will understand the slush molding process as evidenced by constructing a plastisol football kicking tee.

EQUIPMENT AND SUPPLIES NEEDED: IASCO No. 90 Liquid Flexible Plastisol, opaque Plastosol pigment, mixing cups, gloves, cooling pan or tank, AA-31 Cast Aluminum football kicking tee mold, oven

REFERENCE MATERIAL: INDUSTRIAL PLASTICS, pages 185-186, by Ronald Baird, Goodheart-Willcox Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
    A. Review the reference material.
2. Teacher Demonstration
    A. Discuss slush molding and its application in industry.
    B. Demonstrate the process by completing the following:
        1. Preheat the kicking tee mold at 350 for 20-25 minutes.
        2. Fill the mold to within ¼" of top with vinyl plastisol No. 65 or No. 90. CAUTION: Use gloves when handling the hot mold.
        3. Carefully place the filled mold back in the oven. Check to see that it is level. Place a cover over the open mold to prevent the center from hardening. Masonite works fine for a cover. Check the time.
        4. Remove the mold from the oven after 5 minutes. Pour out the liquid center. The sides of the kicking tee will be approximately ¼" thick. If a thicker cross-section is desired, leave the mold in the oven several minutes longer before pouring out the center.
        5. Place the mold back in the oven for 20-25 minutes to cure. After curing, place the mold in cold water to cool.
        6. Remove the completed tee from the mold. Trim and shape the bottom of the kicking tee if desired.
        7. The completed tee will weigh approximately 7-8 ounces, or 90 plastisol or a mixture of these may be used.
3. Student Activity
    A. Allow each student to complete the forming process by following the procedures listed above.

PROCESS: COMBINING AND FORMING
MATERIAL: PLASTICS

ACTIVITY
"Film: Foam Molding"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will demonstrate his knowledge of foam molding as evidenced by naming five items made from flexible urethane foam.

EQUIPMENT AND SUPPLIES NEEDED: 16mm projector

REFERENCE MATERIAL: Film: FURS TO FEATHERS TO FOAM
Mobay Chemical Co., Advertising Dept.
Pittsburgh, PA. 15205

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Preview the film.
   - B. Show the film.
   - C. Discuss the industrial applications of urethane foam molding.
2. Student Activity
   - A. Have the students list on a sheet of paper five items made from flexible urethane foam.

PROCESS: COMBINING & FORMING
MATERIAL: PLASTICS

ACTIVITY
"Film: Facts About Foam"

Allow 1 class period

OBJECTIVE: After viewing the film the student will apply his knowledge of the foam molding process by naming ten foam products.

EQUIPMENT AND SUPPLIES NEEDED: 16mm film projector

REFERENCE MATERIAL: FACTS ABOUT FOAM, 16mm sound, b/w, 20 minutes
The Dow Chemical Co., Visual-Aids Dept.
Abbott Road Building, Midland, Mich. 48641

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Preview the film.
   - B. Show the film.
   - C. Discuss the film, relating the process and the key points to industry.
2. Student activity
   - A. List 10 products produced from foam plastic material.

PROCESS: COMBINING & FORMING
MATERIAL: PLASTICS

ACTIVITY
"Foam Molding"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will demonstrate his knowledge of foam molding as evidenced by successfully making a duck decoy.

EQUIPMENT AND SUPPLIES NEEDED: Electric hand drill and mixer paddle, Urethan foam components, acetone, containers for mixing, rubber gloves, small cups, postal scale

REFERENCE MATERIAL: Plastik-Labs, pages 58-61 (I)

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material.
   - B. Discuss the process of foam molding and indicate industrial uses for this process.
2. Teacher Demonstration
   - A. Clean the duck decoy mold to remove any old foam.
   - B. Brush on an even coat of special mold release and let it dry for 15 or 20 minutes. It is very important to cover the entire mold cavity, especially the head part. When dry, inspect the mold surfaces. They should be dull. Any shiny surface indicates that there is not any mold release present. Shiny surfaces should be recoated.
   - C. Assemble the duck decoy mold. Tighten finger tight.
   - D. Measure three ounces of component A and 3 ounces of component B. It is very important that the materials be at room temperature to foam properly.
   - E. Mix the components together for 20 to 25 seconds using a wire mixer with an electric drill. The components should be mixed as quickly and thoroughly as possible.
   - F. Pour the foam into the mold using a polyethylene funnel.
   - G. Separate the mold after an hour of curing.
   - H. Paint the duck using a duck decoy paint kit.
3. Student Activity
   - A. Allow each student to complete the process by following the procedures listed above.

BEST COPY AVAILABLE

(c) Plastik/Labs, Wichita, Kansas

PLASTIK-LABS Student Workbook, pages 58-61

PROCEDURE:

Foaming is a process of casting or molding in which a plastic resin is expanded and fused by physical or chemical means. Materials that are currently used include polyurethane, polystyrene, vinyl, polyethylene, phenolic, silicone and cellulose acetate. The structure of the foam can be varied from flexible to rigid. The cell structure can be formed by chemical or physical means. The blowing agent, which causes the cell structure, can be introduced as the resin is extruded or by a chemical reaction which takes place when two components are mixed together.

The first foam was the result of a reaction between phenol and formaldehyde by Dr. Leo H. Baekeland. At the time, he was trying to develop a nonporous resin instead of a foam. He finally succeeded in 1910 to develop a nonporous resin, phenolic. It wasn't until 1945 that the need arose for foams. It was then that phenolic foams were fully developed. Phenolic foams, and later epoxy foams, were used to encapsulate delicate electronic components. During World War II urea, vinyl, urethane and polystyrene foams were developed. Their applications at that time included insulation, flotation devices and a structural reinforcement for aircraft.

Polyurethane is the most widely used foam. The foam may be polyester-based or polyether-based. Each type can be designed to be either flexible or rigid. Urethane foams are produced by the reaction of polyols, either polyester or polyether, with isocyanates and a blowing agent which could be carbon dioxide or freon. The density of urethanes can range from about one pound per cubic foot to about 70 pounds per cubic foot, depending on its formulation.

The flexible urethane foam that you will use later in this unit is a two-component system which is a polyester-based resin. The blowing agent, which causes the resin to foam, is carbon dioxide which is generated by the chemical reaction. The rigid foam is also a two-component system but is a polyehter-based resin. The blowing agent for the rigid foam will be freon gas.

Flexible foams have what is called an open-cell structure, which means the cells do not have a closed cell wall between all of them. Because of this structure, flexible foams have different characteristics than rigid foams. Flexible urethane foam will absorb water and is very resilient in that it will always return to its original shape after being crushed. Flexible foams are also tough and almost impossible to tear.

Because of their special properties, flexible urethanes have largely replaced rubber foams. Urethanes do not deteriorate as do rubber foams and they are less expensive than rubber foams. Since flexible urethane foams are resilient and very tough, they find many applications in the form of pillows, seat cushions and safety padding in automobile arm rests, sun visors and dash boards.

(c) Plastik/Labs, Wichita, Kansas

Rigid foams have a closed-cell structure, each cell being enclosed by plastic. Because of this structure, rigid foams will float quite well. Rigid urethanes are the best foams for insulating against heat and cold. They have the highest insulative value of any known material.

Since rigid urethane foam has a closed cell structure, it makes an excellent material for life preservers and in boats to prevent their sinking. Because of its low thermal conductivity, it is an excellent material for insulating from heat and cold as in refrigerators and buildings. The rigid foam can be foamed in place between the walls of a building or sprayed to any surface.

PROCESS: FORMING
MATERIAL: PLASTICS

ACTIVITY
"Transfer Molding"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will understand the transfer molding process as related to industry as evidenced by participation in class discussion.

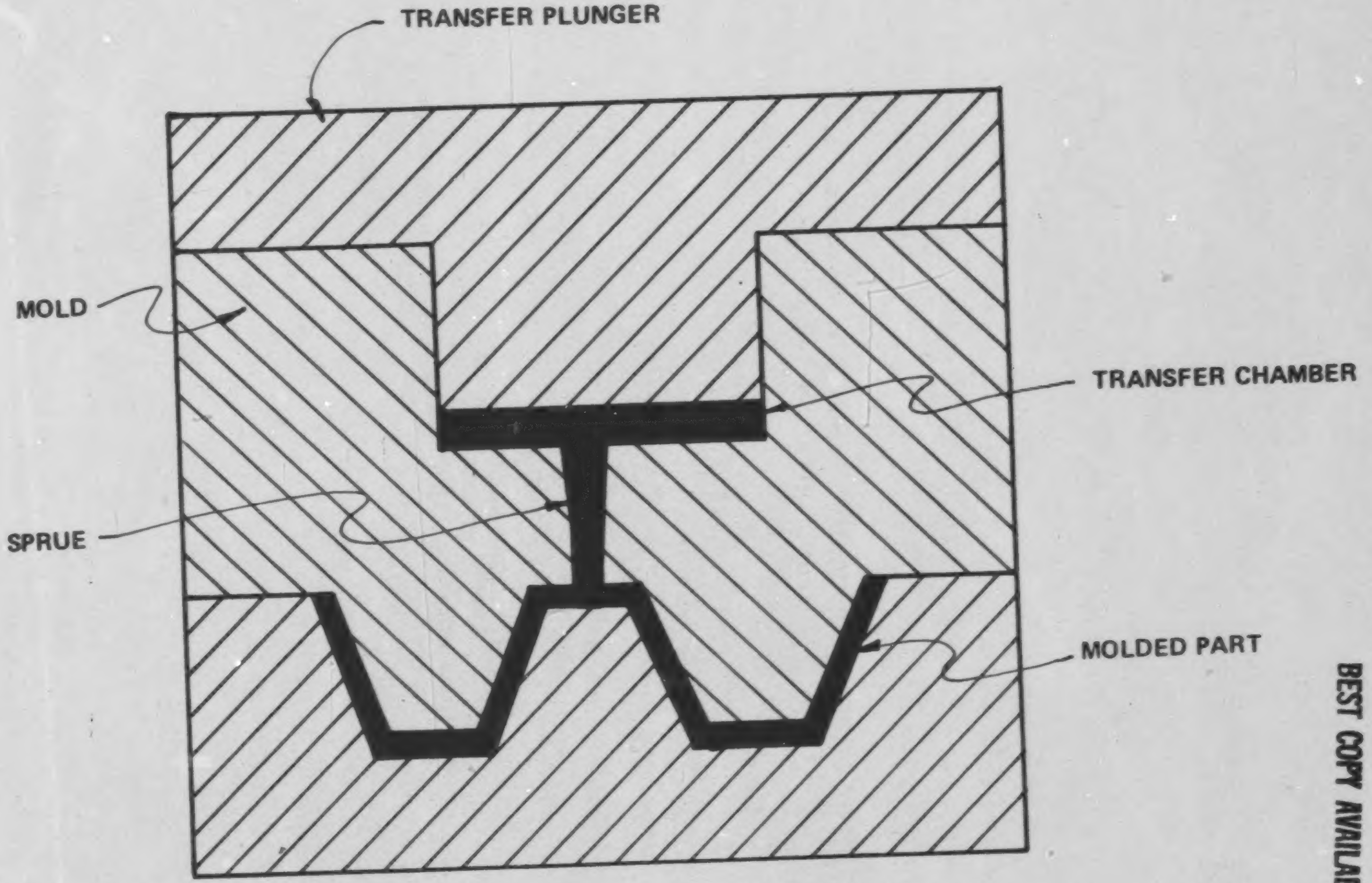
EQUIPMENT AND SUPPLIES NEEDED: Sample of product (distributor cap, handles from pots and pans, etc.)

REFERENCE MATERIAL: Pamphlet–COMPRESSION & TRANSFER MOLDING
Soc. of Plastics Industries
Transparency master included
INDUSTRIAL PLASTICS, pages 131-132, , by Baird, Goodheart-Willcox Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material.
2. Teacher Presentation
   - A. Discuss transfer molding
   - B. Compare the process with compression molding.
   - C. Compare the process with injection molding.
   - D. Present the advantages of transfer molding over compression molding.
   - E. Indicate materials used for transfer molding.
   - F. Discuss the limitations of transfer molding.
3. Student Activity
   - A. Allow each student to participate in the discussion.

TRANSFER MOLDING


TRANSFER PLUNGER
MOLD
TRANSFER CHAMBER
SPRUE
MOLDED PART

PROCESS: FORMING
MATERIAL: PLASTICS

ACTIVITY
"Film: Blow Molding"

Allow 1 class period

OBJECTIVE: *At the completion of this activity the student will understand the blow molding process as evidenced by successfully answering teacher prepared questions.*

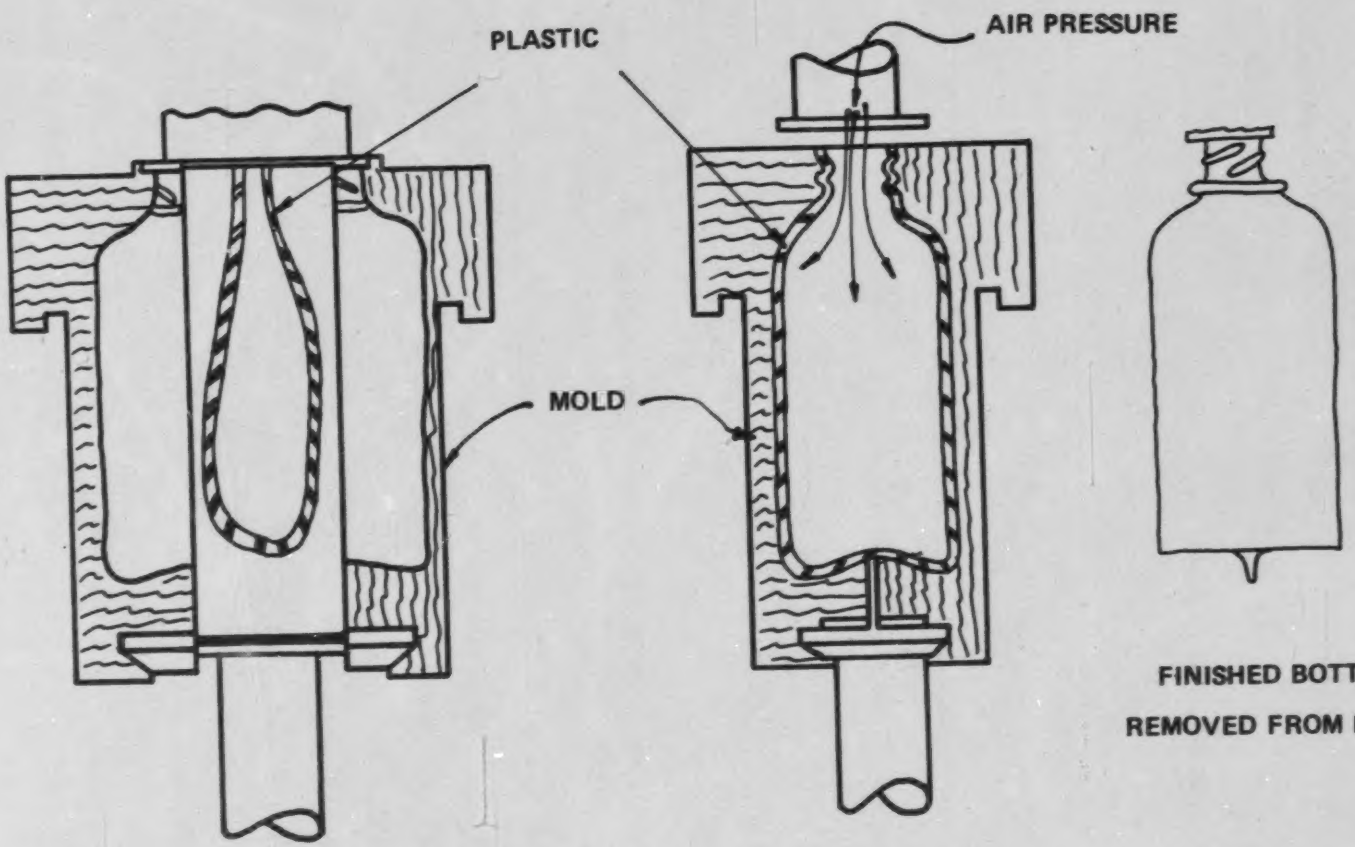
EQUIPMENT AND SUPPLIES NEEDED: Sample products (bottles, containers, etc.),
16mm projector

REFERENCE MATERIAL: INDUSTRIAL PLASTICS, pages 115-116, by Baird, Goodheart-Willcox Co.
Film: HIGH SPEED BOTTLE IMPACT
Mr. P.E. Campbell, Mgr., Tech. Inf., Sales Service Lab.
Phillip Pertroleum Co., Bartesville, Oklahoma 74003
Transparency Master on Blow Molding (included)

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
    - A. Review the reference material.
    - B. Preview the film.
    - C. Show the film.
    - D. Discuss the process. Make a transparency from the master included.
2. Student Activity
    - A. Answer questions about
        1. Dies and molds used for extrusion of porison
        2. How molds are made
        3. Special finishes on products
        4. Special coatings
    - B. Give examples of blow molding.

BLOW MOLDING


PLASTIC
AIR PRESSURE
MOLD

EXTRUDED PARISON—MOLD OPEN

BOTTLE BLOWN
MOLD CLOSED

FINISHED BOTTLE
REMOVED FROM MOLD

PROCESS: FORMING
MATERIAL: PLASTICS

ACTIVITY
"Injection Molding"

Allow 2 class periods

OBJECTIVE: At the completion of this activity the student will demonstrate his ability to set-up and operate an injection molder to produce a product as evidenced by the completed product.

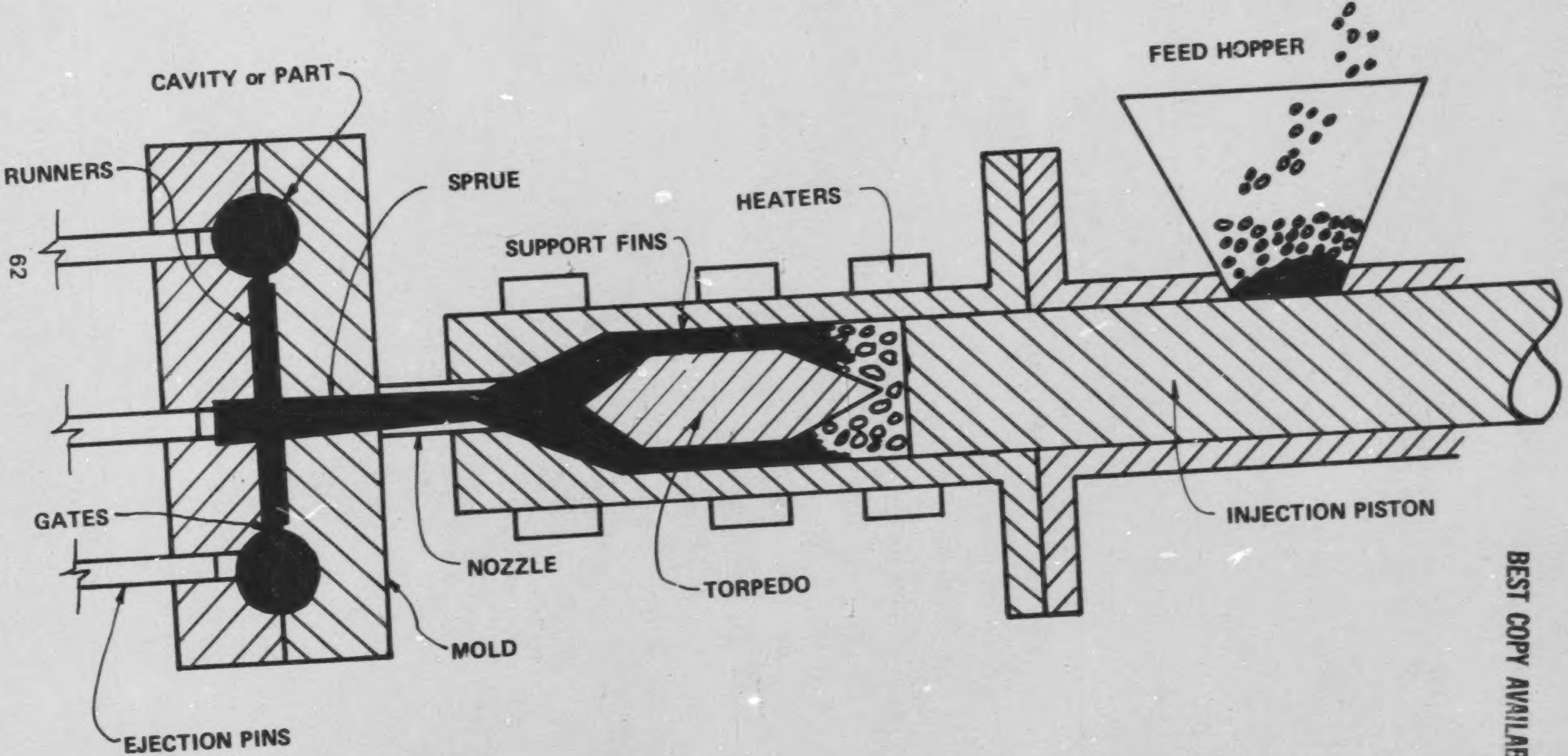
EQUIPMENT AND SUPPLIES NEEDED: Polyethelene pellets, color pigment, mold release, injection molder, and mold

REFERENCE MATERIAL: Film strip--Plastik Lab not included
Transparency master included
DCA: Overhead transparency on injection molding not included
INDUSTRIAL PLASTICS, page 85, by Baird, Goodheart-Willcox Co. not included

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   A. Review the reference material.
   B. Preview the film strip.
2. Teacher Presentation
   A. Show the Plastik Lab filmstrip. The industrial application of injection molding and the various kinds of machines are presented in the filmstrip.
   B. Discussion of the injection process.
   C. Explain the process using the transparency.
   D. Demonstrate the use of the injection molder equipment and the operation procedure.
   E. Check manufactures information sheet.
3. Student Activity
   A. Allow each student to inject mold a product by following the procedure demonstrated.

INJECTION MOLDING


CAVITY or PART
RUNNERS
SPRUE
HEATERS
SUPPORT FINS
FEED HOPPER
GATES
NOZZLE
TORPEDO
INJECTION PISTON
MOLD
EJECTION PINS

PROCESS: FORMING
MATERIAL: PLASTICS

ACTIVITY
"Compression Molding"

Allow 2 class periods

OBJECTIVE: At the completion of this activity the student will demonstrate his knowledge of compression molding as evidenced by successfully forming a coaster in one class period.

EQUIPMENT AND SUPPLIES NEEDED: Phenolic powder, mold release, gloves, sandpaper, measuring cups, steel wool, brass rod, compression molder, coaster mold, triple beam investment scale.

REFERENCE MATERIAL:
Filmstrip: Plastik Lab Compression Molding not included
DCA: Compression Molding Transparency not included
Transparency master included
Procedures for compression molding included

1. Teacher Information
   - A. Review the reference material.
   - B. Preview the filmstrip.
   - C. Show the filmstrip.
2. Teacher Presentation
   - A. Discuss the compression molding process. Use the transparency to explain the process. Note common products made by compression molding.
   - B. Demonstrate to the class the basic operations and identification of the functional parts of a compression molder. NOTE especially the items listed in the procedure section on the following sheet.
   - C. You may wish to provide the student with a sheet listing the procedures for making the coaster.
3. Student Activity
   - A. Allow each student to form a coaster by following the procedures presented by the teacher.

COMPRESSION MOLDING

Compression Molding is the simplest type of molding and the most common method by which thermosetting plastics are molded.

The Process

There are five phases in the compression molding process. First, the plastic in the form of powder, pellets, or preformed discs is preheated to dry it and to raise its temperature nearer to the curing range. Second, the plastic "charge" is loaded directly into the mold cavity which is commonly held at a temperature between 300 degrees and 400 degrees F, depending upon the material. Third, the mold is partially closed; the heat and exerted pressure cause the plastic to liquify and begin to flow into the recesses of the mold. Fourth, the mold is fully closed, causing the plastic to complete its flow and cure. Fifth, after the cure is completed, the mold is opened for ejecting the molded part.

CHARACTERISTICS AND APPLICATIONS

Compression molding is ordinarily used for thermosetting plastics. Alkyds, melamine, urea, and phenolics are often processed in this manner. Since thermosets harden by means of a chemical change which is aided by the addition of heat, the mold remains hot throughout the entire cycle and is immediately ready for a new charge of plastic as soon as the previously molded part is ejected. However, thermoplastic must cool to harden; this necessitates cooling the entire mold at the conclusion of each cycle before the part can be ejected. This necessity slows down the molding process considerably. Nevertheless, phonograph records of vinyl and styrene are compression molded because of the extreme accuracy that is needed for proper sound reproduction.

Compression molding is ideal for products with a large area and deep draw. Electrical switch gear is made in this manner. Plastic dinnerware is commonly compression molded. Radio and television cabinets, furniture drawers and other caselike products are common applications. Many small items such as buttons, knobs, handles, and electrical parts are compression molded in multiple-cavity molds.

PROCEDURES FOR FORMING PLASTIC COASTERS USING THE COMPRESSION MOLDER.

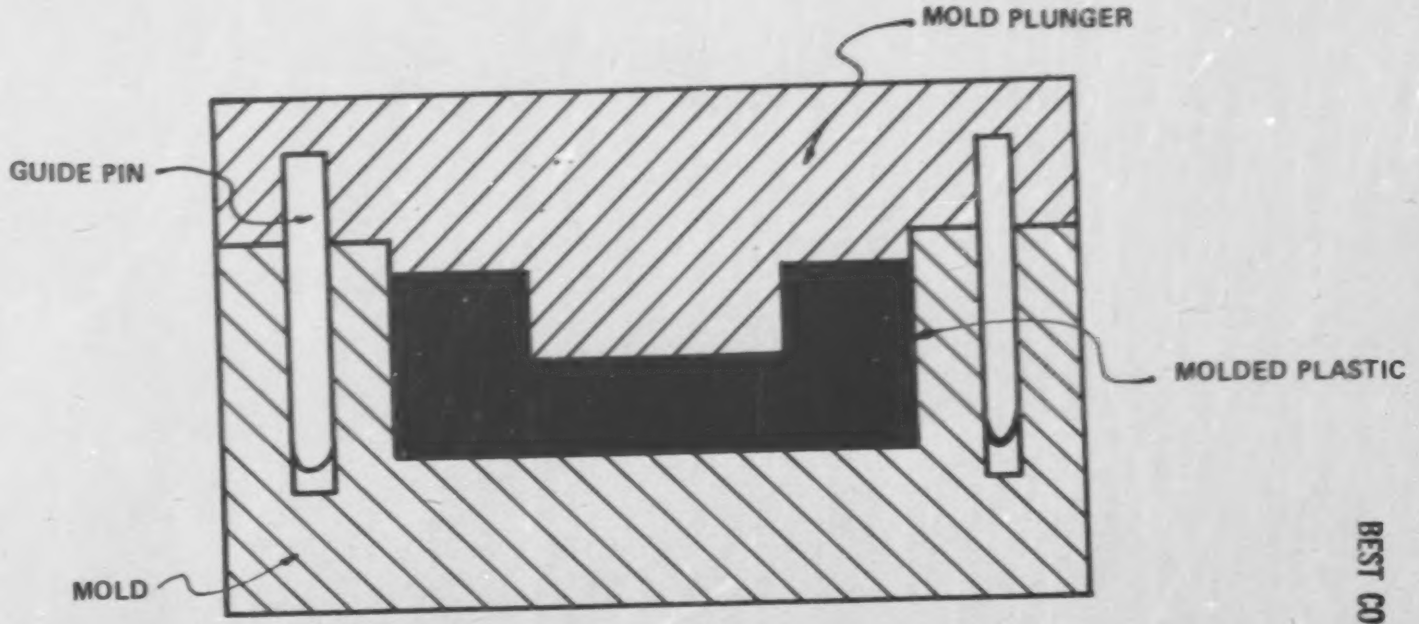
1. CLEAN THE MOLD. Remove all oil, dirt, foreign material or particles of plastic left from the previous cycle. For scraping or cleaning use only blunt pointed brass rod.
2. MOLDING TEMPERATURE. Heat the press platens to 300 degrees F. Place the mold in the press for about 15 minutes with the press closed. (no pressure)
3. MOLD RELEASE. Apply mold release to the inside of the two mold halves Remove the mold from the press to spray the mold release.

4. FILL THE MOLD. Approximately 28 grams of PHENOLIC PLASTIC is required to mold one coaster. Measure the proper amount on a triple beam investment scale. Pour into the mold and assemble.

5. CLOSE THE PRESS. With the mold located near the center of the bottom platen, bring the press up to its maximum pressure 25 tons (50,000 p. s. i.) and apply pressure for 15 seconds while the material flows through the cavity. Molding time should be 2 minutes.

6. OPEN THE PRESS. Use gloves to remove the mold. The part may be removed from the cavity by pressing the ejector pin and loosening the part. Remove the flash from the finished part with a small file or a sanding block.

COMPRESSION MOLDING


MOLD PLUNGER
GUIDE PIN
MOLDED PLASTIC
MOLD

PROCESS: FORMING
MATERIAL: PLASTICS

ACTIVITY
"Rotational Molding"

Allow 2 class periods

OBJECTIVE: At the completion of this activity the student will demonstrate his knowledge of rotational molding by producing a football.

EQUIPMENT AND SUPPLIES NEEDED: **Football mold, high density polyethylene powder, coloring pigment, mold release, gloves, Emco Rotational Molder**

REFERENCE MATERIAL: **Plastik Lab Filmstrip/cassette on Rotational Molding not included**
Transparencies on Rotational Molding (DCA) not included

PROCEDURE FOR THE ACTIVITY

1. Teacher Information

   A. Preview the filmstrip/cassette.

   B. Show the filmstrip/cassette.

2. Teacher Presentation

   A. Discuss the industrial process of rotational molding and give examples of products produced by this method.

   B. Demonstrate the basic operations and identification of functional parts of the rotational molder and procedures to follow in constructing the football. Note especially the items listed in the procedure section on the following sheet.

   C You may wish to provide the student with a sheet listing the procedures for making the coasters.

3 Student Activity

   A. Alloweach student to form a football by following the procedures demonstrated.

ROTATIONAL MOLDING

Rotational molding is a method of molding a hollow plastic product which is completely enclosed. The rotating device must be mounted so that it will permit the mold to revolve in two directions simultaneously in order to provide even distribution and heating. Plastic powder, plastic liquids may be formed by using rotational molding. Rotational molding is a process which requires three major functions, a mold loading station, a heating oven, a cooling station.

A number of plastic materials can be used for powder molding and coating. The most common materials used for rotational molding are polyvinyl chloride, polyethylene, nylon, epoxies, and high impact polystyrene. Polyvinyl chloride has outstanding toughness, durability, and electrical insulating properties. Polyethylene powders offer excellent chemical resistance and low water absorption. They also offer material flexibility. Powdered nylon, although more expensive than most other plastics, is easy to process, is hard, tough, and is resistant to abrasion. Epoxy powder, the main thermosetting material used, is primarily selected for electrical insulating application where hardness and high heat resistance are required.

During the molding process the powder is evenly spread over the mold surface. As the resin melts, it forms a solid coating on the inside of the mold to provide the required product shape. Equipment for the rotational molding process is usually less costly and production cycles are slower.

The molds for rotational molding are usually made of cast aluminum. Aluminum is easily machined, conducts heat and cold quickly, and is light in weight. Molds too large to cast in aluminum are made of fabricated sheet steel.

The versitility of design for rotational molding is almost unlimited. Flexibility or rigidity is built into the product by the use of many resins now available on the market. Typical products include large commercial and industrial containers, traffic cone markers, sporting equipment such as footballs, golf carts, helmets, and insulated ice chests.

PROCEDURES FOR CONSTRUCTION OF PLASTIC FOOTBALL

1. The inside of the mold is coated with a mold release.
2. Fill ½ of the mold (1 mold half) with either high or low density polyethylene powder.
3. Clamp the mold together.
4. Place mold in oven mold holder and fasten so that it won't move.
5. Set the timer at 30 minutes and the temperature dial at 425 degrees F.
6. Turn the light on inside the oven. Set the speed control knob on 40 and turn on the motor.
7. When the required molding time has elapsed and while the mold is still rotating cool the mold by spraying it with water until droplets do not boil off.
8. Stop rotation. With glove, remove mold and dip in cool water and take the mold apart.
9. Remove the product.

PROCESS: COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Printing by Adhesion"

Allow 2 class periods

OBJECTIVE: At the completion of this activity the student will demonstrate his knowledge of printing as a combining process by silk screening an image on a piece of acrylic.

EQUIPMENT AND SUPPLIES NEEDED: Squeegee, silk screen unit, (Naz Dar or equal) ink or paint, small pieces of acrylic

REFERENCE MATERIAL: INDUSTRIAL PLASTICS, page 258, by Baird, Goodheart-Willcox Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
    - A. Review the reference material.
2. Teacher Presentation
    - A. Have a brief discussion on silk screening and its application in industry.
    - B. Demonstrate the process by:
        1. Place the stencil onto the silk screen and glue into place.
        2. Place a scrap piece of paper under silk screen frame. Lower the frame onto the paper.
        3. Spread a small amount of silk screen ink onto the top of the silk screen.
        4. Pull the squeegee into the ink and over the design. Hold the squeegee at a slight angle and apply an even pressure.
        5. Remove the paper and check the design.
        6. If the design is satisfactory, place a piece of acrylic under the screen and repeat steps 3, 4, and 5.
3. Student Activity
    - A. Allow each student to complete the combining process (adhesion) by following the procedures demonstrated.

PROCESS: COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Thermal Heat Sealing"

Allow 1 class period

OBJECTIVE: At the conclusion of this activity the student will demonstrate how heat sealing may be accomplished as evidenced by the successful completion of the product.

EQUIPMENT AND SUPPLIES NEEDED: Steel square, vinyl sheets 8" x 16", and thermal heat sealer

REFERENCE MATERIAL: INDUSTRIAL PLASTICS, pages 239-242, by Baird, Goodheart-Willcox Co.
Film: TARPALIN SEALING
Thermatron Div. of Willcox & Gibbs Inc.
44-16 23rd St., Long Island City, N.Y. 11101

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material.
   - B. Preview the film TARPALIN SEALING
   - C. Show the film to the students.
2. Teacher Presentation
   - A. Discuss combining by thermal heat sealing.
   - B. Demonstrate the process by:
     1. Heat the bar to 375 degrees F.
     2. Cut vinyl sheet 8" x 16".
     3. Fold vinyl in half and seal three edges with exception of the corner.
     4. Inflate pillow with air and quickly seal corner.
     5. Trim seal to a 1/8" width.
3. Student Activity
   - A. Allow each student to make a pillow by following the procedure demonstrated.

PROCESS: COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Fluidized Bed Coating"

Allow 1 class period

OBJECTIVE: *At the completion of this activity the student will demonstrate his knowledge of fluidized bed coating as a combining process as evidenced by coating tool handles.*

EQUIPMENT AND SUPPLIES NEEDED: Pliers, polyethylene powder, primer, steel wool, fluidized bed coating chamber, air compressor, and oven

REFERENCE MATERIAL: INDUSTRIAL PLASTICS, pages 149-152, by Baird, Goodheart-Willcox Co.
PLASTIK LAB WORKBOOK, pages 26-27

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
    - A. Review the reference material.
2. Teacher Presentation
    - A. Discuss the application of fluidized bed coating to industry.
    - B. Give demonstration on fluidized bed coating of tool handles.

Procedure:

1. Heat the oven to 500 degrees F.
2. Clean the pliers (or any metal tool) handles with steel wool.
3. Dip the handles in a primer. Set them aside to dry.
4. After the handles are dry, suspend the pliers with a piece of wire in the 500 degree F oven for five minutes.
5. Adjust the air supply to the fluid box so that the powdered polyethylene will be suspended in the box.
6. Remove the pliers from the oven and dip them into the fluidizer.
7. Move the pliers in a circular motion for about 13 seconds.
8. Place the pliers back into the oven for one to three minutes to allow the resin to melt and flow out.
9. If thicker coating is desired, the pliers may be dipped again.

10. After the material flows out to a smooth, shiny coating, cool in water for about five minutes.

11. Trim off excess using a razor cutter.

3. Student Activity

   A. Have the students bring a metal tool from home to coat. Students should complete the process by following the procedures demonstrated.

PROCESS: COMBINING
MATERIAL: PLASTICS

ACTIVITY
"High Pressure Laminating"

Allow 1 class period

OBJECTIVE: *At the completion of this activity the student will demonstrate his understanding of high pressure laminating by completing the assigned activity.*

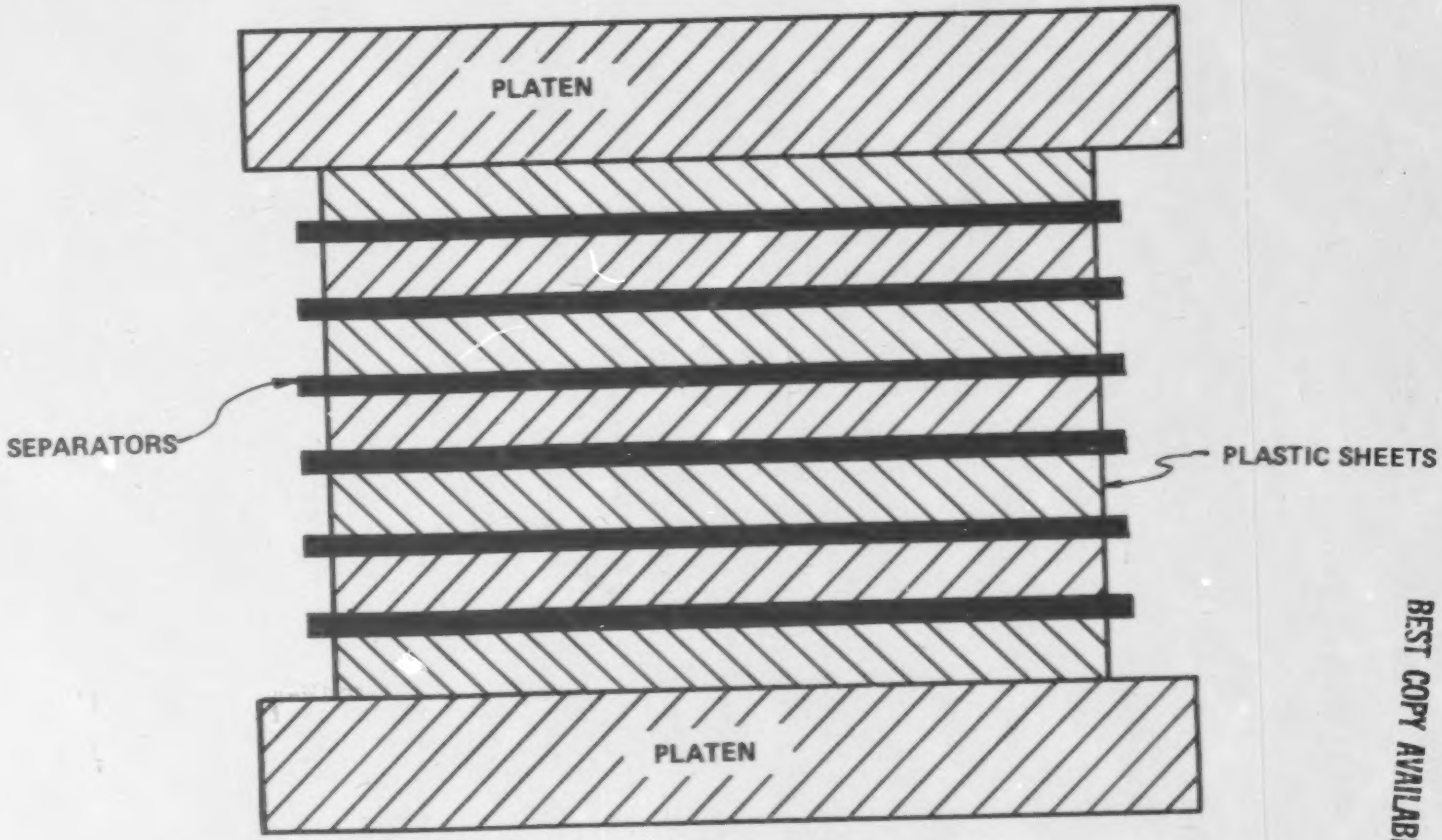
EQUIPMENT AND SUPPLIES NEEDED: Melamine overlay sheet, melamine decorative sheet, phenolic impregnated kraft paper, laminating press, polished plates

REFERENCE MATERIAL: Filmstrip–Plastik Lab HIGH PRESSURE LAMINATING
Transparency master included

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Preview the filmstrip
   - B. Show the filmstrip.
2. Teacher Presentation
   - A. Discuss high pressure laminating and its application. Use the transparency included for better understanding.
   - B. Demonstrate the process by following the procedure listed.
     1. Heat press to 350 degrees F.
     2. Cut sheets of material 3" x 3" (Melamine overlay, melamine decorative and phenolic impregnated kraft paper)
     3. Arrange layers between polished plates.
     4. Determine pressure at 1500 psi. Apply pressure.
     5. Heat under pressure for 10 minutes.
     6. Release pressure.
     7. Remove the sandwich (polished plates and material) from the press.
     8. Allow plates to cool.
3. Student Activity
   - A. Allow each student to laminate by following the procedures demonstrated.

HIGH–PRESSURE LAMINATING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SEPARATORS
PLASTIC SHEETS
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PROCESS: COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Fusion Welding"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will demonstrate his knowledge of fusion welding by welding two pieces of pipe together.

EQUIPMENT AND SUPPLIES NEEDED: PVC pipe sections, hot plate, and band saw

REFERENCE MATERIAL: INDUSTRIAL PLASTICS, page 225, by Baird, Goodheart-Willcox Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information

    A. Review the reference material.

2. Teacher Presentation

    A. Discuss fusion welding--note its application in industry.

3. Student Activity

    A. Have each student select two short (3") pieces of PVC pipe and place them on the hot plate until the surface ends are molten. The two pieces should then be quickly pressed together to fuse the two parts and form the weld.

    B. The student should hand in the welded pipe. After it has been evaluated, have the student break the weld or cut it in half. The pieces may be used by another.

PROCESS: COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Bonding"

Allow 2 class periods

OBJECTIVE: At the completion of this activity the student will understand bonding as evidenced by performing laboratory experiments dealing with the effect of solvent cement on various plastics.

EQUIPMENT AND SUPPLIES NEEDED: Solvent and cements, various plastic materials

REFERENCE MATERIAL: INDUSTRIAL PLASTICS, page 82, by Baird, Goodheart-Willcox Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   A. Review the reference material.
2. Teacher Presentation
   A. Discuss bonding, solvents, and materials.
3. Student Activity
   A. Have the student study the effects of solvent cement on a number of plastic resins by placing a drop of each solvent on the surface of each resin. Record the results. Submit a one page report to the teacher with comments about the results.

PROCESS: COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Cast Embossing"

Allow 2 class periods

OBJECTIVE: At the completion of this activity the student will demonstrate his knowledge of cast embossing as combining process by completing the assigned product.

EQUIPMENT AND SUPPLIES NEEDED: Warren Striphote release paper (IASCO), brush, No. 65 plastisol, oven, heat sealing machine

REFERENCE MATERIAL:

PROCEDURE FOR THE ACTIVITY

1. Teacher Information

   A. Cast embossing is a simple process of coating a strip of release paper with a vinyl plastic material. The process is used in making pattern vinyl. Some products that can be made by this process are: billfolds, purses, comb cases, tool cases, belts, etc.

2. Teacher Presentation

   A. Discuss cast embossing--the process of making vinyl fabric.

   B. Demonstrate the procedure for cast embossing a piece of vinyl by completing the following procedure.

      1. Pour a thin coat of No. 65 plastisol on a sheet (6" x 6") of Warren Striphote release paper.

      2. Place the Striphote on a metal cookie sheet and place in oven at 210 degrees F for 2 minutes. This step pre-gels the material.

      3. Increase oven temperture to 375 degrees. Allow strip to remain in oven for 2 minutes to cure.

      4. Allow the strip to cool at room temperature. When cool, strip away the Striphote pattern. NOTE: You may wish to increase the strength of the vinyl fabric by adding cotton cloth during Step No. 1.

3. Student Activity

   A. Allow each student to complete the cast embossing process by following the procedures demonstrated by the instructor.

PROCESS: COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Film: Plastic Adhesion"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will understand Ultrasonic Sealing and its relationship to industry as evidenced by correctly answering test questions about the process.

EQUIPMENT AND SUPPLIES NEEDED: Test for students and 16mm projector

REFERENCE MATERIAL: Film: ULTRASONIC ASSEMBLY
Branson Sonic Power Co.
Eagle Rd., Danburg, Conn. 06810

BIELOMATIK
Therrstron Division of Willcox
& Gibbs, Inc., 44-16 23rd St.
Long Island City, N.Y. 11101

1. Teacher Information
    A. Preview the film.
    B. Show the film.
2. Teacher Presentation
    A. Discuss the adhesion process and the main points from the film.
    B. Relate adhesion to metals, wood, plastics and earth products.
3. Student Activity
    A. Take notes over the material presented in the film.
    B. Answer the questions provided by the teacher.

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PROCESS: COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Fusion Welding"

Allow 1 class period

OBJECTIVE: At the conclusion of this activity the student will understand the process of gas welding on plastic materials and how these processes are related to industry as evidenced by the completed welds.

EQUIPMENT AND SUPPLIES NEEDED: Acrylic (2 pieces 4" x 6"), or two pieces of polyethylene sheet 6" long, and hot gas torch

REFERENCE MATERIAL: INDUSTRIAL PLASTICS, page 228-229, by Baird, Goodheart-Willcox Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material.
2. Teacher Presentation
   - A. Discuss the fusion welding.
   - B. Demonstrate fusion welding by following the procedures listed below.
     1. Select 2 pieces of polyethylene sheets or 2 acrylic sheets.
     2. Connect air (gas) supply to welder.
     3. After gas is flowing, turn on the heating element and allow the gun to warm up.
     4. Be sure to turn on the gas first, as the heating element may burn out if gas is not flowing around it at all times.
     5. Select a rod made from same material as the sheet material being used.
     6. Check temperature of welder. Refer to chart to determine correct temperature for material used. INDUSTRIAL PLASTICS, page 271.
     7. Direct the hot gas to the joint and the tip of the rod until both are molten.
     8. As the rod and surface melt, fusion takes place and the rod deposits a bead in the joint. Move the rod slowly along the joint.
     9. The weld is continued to the end of the joint at which time the rod may be pressed into the surface, heat removed, and the rod allowed to cool.
     10. Finish the surface, by cutting off the rod with a knife.

PROCESS: COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Low Pressure Laminating"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will demonstrate his understanding of low pressure lamination by completing the assigned activity.

EQUIPMENT AND SUPPLIES NEEDED: Vise-grips, scissors or snips, abrasive paper, .015 cellulose acetate, card blotters, laminating press, holding plates, polished plates, thermometer, and water supply

REFERENCE MATERIAL: INDUSTRIAL PLASTICS, pages 191-192-193, by Baird, Goodheart-Willcox Co.
Plastik Lab Filmstrip: DCA-Transparency

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material
   - B. Preview the film strip.
   - C. Show the filmstrip.

2. Teacher Presentation
   - A. Discuss combining by low pressurellaminating. Discuss industrial applications of laminating. Use the transparency for better understanding.
   - B. Demostrate the process by completing the procedures listed.
     1. Select a 3" x 5" card.
     2. Select a piece of vinyl or cellulose acetate, cut to 4" x 6" size
     3. Preheat press to 350 degrees F.
     4. Make sandwich in sequence.
     5. Clamp together the plates with vice grips and insert in press.
     6. Determine pressure in load pounds. load pounds = psi x sq. in. of
        5,250 = 350 x 15 surface area
     7. Press for 9 minutes.
     8. Cool to 150 degrees F.
     9. Apply some amount of pressure for 5 minutes.
     10. Remove and trim to size, leaving ¼" edge.
     11. File off all marks caused by the sander.
     12. Sand with No. 320 wet and dry. Use water as lubricant.
     13. File blade section to desired shape and then file and sand in same manner as handle section.
     14. Buff and polish entire letter opener.

3. Student Activity
   - A. Allow each student to complete a letter opener by following the procedures demonstrated.

PROCESS: COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Calendering"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will understand the combining process of calendering as evidenced by his participation in class discussion.

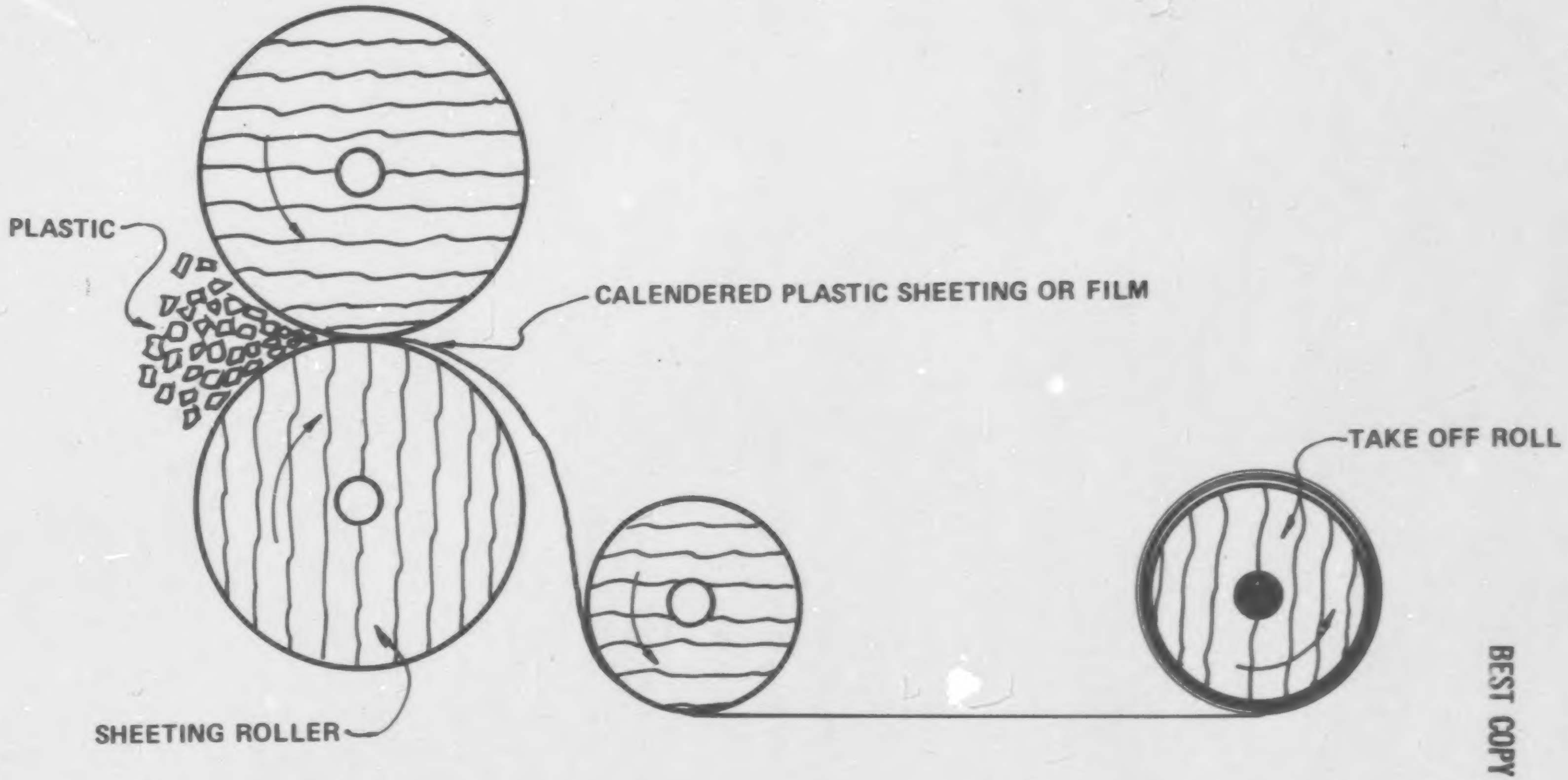
EQUIPMENT AND SUPPLIES NEEDED: Examples of calender coated products (vinyl material)

REFERENCE MATERIAL: INDUSTRIAL PLASTICS, by Baird, Goodheart-Willcox Co.
Transparency master included

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
    A. Review the reference material.
    B. Relate the process to sheet metal fabrication and paper manufacturing.
2. Teacher Presentation
    A. Discuss the calendering process. Use the transparency included to aid student understanding.
    B. Show examples of calendered material.
3. Student Activity
    A. Have students participate in discussion and provide other examples of calendared material.

CALENDERING


PLASTIC
CALENDERED PLASTIC SHEETING OR FILM
TAKE OFF ROLL
SHEETING ROLLER

PROCESS: COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Cold Dipping"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will apply his knowledge of cold dipping as a combining process as evidenced by dipping a tool into the plastic material.

EQUIPMENT AND SUPPLIES NEEDED: Dipping pot, cellulose acetate butyrate

REFERENCE MATERIAL: Plastik Lab Workbook, page 29 included

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
    - A. Review the reference material.
2. Teacher Presentation
    - A. Discuss the application of cold dipping and its application in industry.
    - B. Demonstrate the process of cold dipping tools. Follow the procedure listed in the reference material.
3. Student Activity
    - A. Have the students bring a tool to be dipped. Students should follow the procedure demonstrated.

Plastik Lab Student Workbook, page 29, 30

Cold dipping is a process of placing a plastic coating on metal. The differences between cold dipping and other coating process are that the metal to be coated is cold and the coating usually is not permanent. Cellulose acetate butyrate and ethyl cellulose are used for most temporary coatings. Since they are thermoplastic resins, the coatings can be stripped and placed back into the pot. The primary purpose of cold dipping is to provide protection to a tool or other metal products. The coating provides protection for a tool with a sharp cutting edge in the event it is dropped during shipment or storage. The plasticizers in the resin migrate to the metal to protect against rust and corrosion. When the product is ready to be used, the coating is slit and peeled off.

PROCEDURE

1. Heat the dipping pot to 360 degrees F by setting the thermostat. When the proper temperature is reached, the light will go out; set the tehrmostat to 325 degrees F.

2. Use steel wool to clean the tool prior to dipping.

3. Dip the cutting edge of the tool into the butyrate for about three seconds.

4. Remove tool from pot.

5. Allow excess butyrate to run into the pot, using a twisting motion. The dripping butyrate will be very hot and will take 5 minutes to cool.

6. After cooling, the material can be peeled off and put back into the pot.

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PROCESS: FORMING & COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Plastisol Molding"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will demonstrate his knowledge of plastisol molding by forming a coin purse.

EQUIPMENT AND SUPPLIES NEEDED: Gloves, coin purse mold, knife, leather punch, plastisol (any color) and an oven

REFERENCE MATERIAL: Plastik-Lab Filmstrip on Coating Process

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material included.
   - B. Preview the filmstrip.
   - C. Show the filmstrip.
2. Teacher Presentation
   - A. Discuss the various coating processes and their application to industry. Relate metal, wood and earth materials to the molding process.
   - B. Demonstrate the process by following the procedures listed in the reference material.
3. Student Activity
   - A. Allow each student to form a coin purse by completing the procedures demonstrated.

PLASTISOL MOLDING

Plastisols are PVC (polyvinyl chloride) resin particles dispersed in plasticizers. Stabilizers, colors and fillers added to plastisols provide proper physical properties. At room temperature the plastisols maintain a syrup consistency. At 350 degrees to 375 degrees F, fusion takes place resulting in a tough, solid mass. Because of this liquid-to-solid conversion, without pressure, plastisols are adaptable to simple, economical molding. Plastisols may be used for dip molded on the exterior of the mold or for slush and rotational molded on the interior of a hollow mold. Typical products produced by the dip molding process are spark plug covers, toys, boots, eyeglass cases. The plastisol material may be applied to tool handles, machine knobs, etc. Slush molding items may be hollow doll parts, and hollow flexible toys. Rotational molded plastisol items consist of basketballs, footballs, toys, etc.

HELPFUL INFORMATION FOR PLASTISOL DIPPING

Fast pre-heating of molds may be accomplished by heating the molds with a bunsen burner, blow torch or gas flame. The mold should be heated uniformily for about 1 minute and then placed in an oven for 3 minutes to modulate the mold to the proper temerpature.

The hotter the mold, the less time will be required to build up desired thickness.

The longer the tool is immersed in plastisol the heavier the coating will be.

Thicker coatings require longer curing cycles.

Proper curing time for plastisol can be visually determined by watching for shiny glossy surface with light to moderate "smoking of surface". A tough, tear resistant and very elastic plastisol product is available if properly cured. If the mold is not tough a longer curing time may be required.

PROCEDURES

The over all cycle for molding of the coin purse is 18-25 minutes (not including mold pre-heating). For most plastisol projects the oven should be set and heated to 375 degrees F.

1. Pre-heat mold in oven to 375 degrees F. This normally takes approximately 10-12 mimutes.
2. Completely immerse and hold mold in plastisol and allow to remain in plastisol for 3-5 mintues to build up desired 3/32" thickness. Mold may be momentarily pulled out during the period to inspect build up.
3. Remove, allow excess to drip off and hang it in oven. Reduce oven temperature to 360 degrees F. Be sure to have drip tray under the hanging mold. Cure in oven for 15-20 minutes.
4. Remove from oven and immerse in cold water for approximately 1 minute.
5. Dry the product and slit the mold on one face from wire to wire.
6. Strip from mold and trim. Punch holes with leather punch in each end and slit.

PROCESS: FORMING & COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Fiberglass Reinforced Plastics"

Allow 5 class periods

OBJECTIVE: At the completion of this activity the student will demonstrate his knowledge of reinforced plastic processes by making a candy dish using reinforced fiberglass material.

EQUIPMENT AND SUPPLIES NEEDED: Tack hammer, tacks No. 10, candy dish mold, PVA mold release, fiberglass mat, Trewax, polyester resin, brush, lacquer thinner, hardener No. 280 wet & dry abrasive, band saw, filmstrip projector, and tape recorder.

REFERENCE MATERIAL: Plastik Lab Filmstrip
DCA Transparency
INDUSTRIAL PLASTICS, pages 199-200, by Baird, Goodheart-Willcox Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   A. Review reference material.
   B. Preview the filmstrip.
   C. Show the filmstrip.
2. Teacher Presentation
   A. Discuss the fiberglass molding process and industrial applications of the process. Use transparency to reinforce key points.
   B. Demonstrate the activity by completing the procedures on the next sheet.
3. Student Activity
   A. Allow each student to form a fiberglass layup by completing the procedure demonstrated.

PROCEDURE:

1. Wax entire jig with rock hard paste wax. Buff and polish.
2. Apply PVA mold release to dowel rods and around all edges of the jig.
3. Stretch burlap over the jig and tack into place. Be sure to remove all wrinkles from the material before tacking.
4. Measure out 2½ oz. of resin into paper cup and drop in 15 drops of hardner.
5. Mix together and apply with brush onto the material using a dabbing motion.
6. Let dry for at least 24 hr. and then apply another coat and let dry.
7. Sand off all rough spots with No. 320 wet and then apply a third coat of resin.
8. Apply a fourth coat of resin and then apply a fiberglass mat on top of resin. Apply a coat of resin on top of the fiberglass.
9. Let dry and sand off all rough spots. Apply a final coat of resin.
10. After the final coat has dried remove tacks from the sides of the jig and remove the bowl in such a manner to avoid cracking the resin and fiberglass.
11. Apply 2 coats of resin to the inside of the bowl. Sand between each coat.
12. Buff and polish slightly after bowl has dried and cured.

PROCESS: SEPARATING & COMBINING
MATERIAL: PLASTICS

ACTIVITY
"Bonding Acrylic"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will demonstrate his knowledge of the separating and combining processes by making a letter opener of bonded acrylic.

EQUIPMENT AND SUPPLIES NEEDED: File, band saw, file card, acrylic, ethylene dichoride, No. 320 wet and dry, water and cup, spring clamps, soak pan, and belt and disc sander

REFERENCE MATERIAL: INDUSTRIAL PLASTICS, pages 221-223, by Baird, Goodheart-Willcox Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
    - A. Review the reference material
2. Teacher Presentation
    - A. Discuss combining by bonding. Relate the bonding process to metals, wood and earth materials. Provide examples of glued and cemented (bonded) products.
    - B. Demonstrate the process by completing the following procedures.
        1. Draw four original designs on paper and select the one you like.
        2. Cut out the design and transfer it onto a small piece of 3/16" acrylic.
        3. Use the band saw and cut out the design.
        4. Rough finish the letter opener blade portion on belt or disc sander.
        5. Layout the two handle sections and cut them out on the band saw.
        6. Apply rubber cement to the backs of the handle sections and press them together.
        7. Sand on belt or disc sander to remove saw marks.
        8. Separate the two handle sections.
        9. Pour a small amount of solvent onto a plate glass and place the two handle sections in the solvent and let soak for a few seconds.
        10. Apply both handle sections onto the blade section and apply slight pressure and then place them in a bench vise and clamp with slight pressure.

PROCESS: SEPARATING, FORMING,
& COMBINING
MATERIALS: PLASTICS

ACTIVITY
"Making a Rubber Stamp"

Allow 1 class period

OBJECTIVE: At the completion of this activity the students will understand forming, combining, and separating by completing a rubber stamp.

EQUIPMENT AND SUPPLIES NEEDED: Stamp, stamp pad, ink, rubber stamp, and lamination press

REFERENCE MATERIAL: Instructions provided with machine.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   A. Review the process of rubber stamp making.
2. Teacher Presentation
   A. Discuss the several materials used. Relate the processes to other materials and processing systems.
   B. Demonstrate the process by following the procedures provided with the machine. Note terms which relate to the printing area. Relate the process to printing processes.
3. Student Activity
   A. Allow each student to make a rubber stamp by completing the procedure demonstrated.

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PROCESS: SEPARATING, FORMING
& COMBINING
MATERIAL: METAL

ACTIVITY
"A Sheet Metal Tool Caddy"

Allow 4 class periods

OBJECTIVE: At the completion of this activity the student will know the basic industrial processes involved in manufacturing sheet metal products as demonstrated by completion of a tool caddy.

EQUIPMENT AND SUPPLIES NEEDED: Basic sheet metal, hand tools, pattern, soldering iron, galvanized steel, rivets, hinges, hasp, handle, solder, and soldering furnace

REFERENCE MATERIAL: GENERAL INDUSTRIES, by Lindbeck and Lathrop, Charles A. Bennett, Co. pages 89-91, 134, 109-112, and 136

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   A. Review the reference material.
2. Teacher Presentation
   A. Discuss the processes involved in the tool caddy.
   B. Demonstrate the procedure for making the caddy by completing the following.
      1. Layout product on sheet metal using template.
      2. Shear product.
      3. Bend product by folding over outside edges.
      4. Bend product sides up on a press die.
      5. Bend corner seam flaps with hammer and anvil.
      6. Punch for handle attachment.
      7. Solder seams.
      8. Rivet handle to box.
      9. End product should be a sheet metal tool caddy.
3. Student Activity
   A. Allow each student to make a tool caddy by completing the procedures demonstrated.

PROCESS: SEPARATING
MATERIAL: METAL

ACTIVITY
"Oxygen/Acetelene Cutting"

Allow 1 class period

OBJECTIVE: *At the completion of this activity the students will have an understanding of the oxygen/acetelene cutting process and its application and relation to industry as evidenced by acheiving a neutral flame and cutting scrap metal.*

EQUIPMENT AND SUPPLIES NEEDED: Scrap metal and oxygen/acetelene cutting torch

REFERENCE MATERIAL: GENERAL INDUSTRIES, page 96, Lindbeck and Lathrop, Charles A. Bennett, Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
    A. Review the reference material
2. Teacher Presentation
    A. Discuss the application of the oxygen/acetelene cutting process to industry.
    B. Relate the process to cutting plastics, wood and earth products.
    C. Demonstrate the following.
        1. carbonizing flame
        2. oxidizing flame
        3. neutral flame
        4. cutting procedure
3. Student Activity
    A. Allow each student to
        1. Achieve neutral flame.
        2. Cut scrap metal.

Class discussion on application and relation to industry.

PROCESS: SEPARATING' FORMING
MATERIAL: METAL

ACTIVITY
"Spinning an Ash Tray"

Allow 4 class periods

OBJECTIVE: At the completion of this activity the student will understand the forming of metals by spinning as evidenced by completion of a metal ash tray.

EQUIPMENT AND SUPPLIES NEEDED: Metal spinning tools, shears, files, pattern, sheet aluminum, metal or wood lathe

REFERENCE MATERIAL: GENERAL INDUSTRY, by Lindbeck and Lathrop, Charles A. Bennett, Co., pages 80-81 and 120-127

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
    - A. Review the reference material.
2. Teacher Presentation
    - A. Discuss the metal spinning process, in application in industry and the relationship of the process to other materials.
3. Student Activity
    - A. Allow each student to spin metal by completing the procedure demonstrated. An ash tray is a simple product which each student could make.
    - B. Peen butt holding grooves, finish and polish as needed.

PROCESS: SEPARATING
MATERIAL: METALS

ADTIVITY
"Etching Metal"

Allow 2 class periods

OBJECTIVE: At the completion of this activity the student will understand the etching of materials by successfully producing an etched product. (I.D. tag, book end, name plate, etc.)

EQUIPMENT AND SUPPLIES NEEDED: Brush, container for etching solution, plastic tongs, lacquer thinner, metal stock (aluminum, brass, copper, etc.) etching solution and etching resist, polishing/buffing equipment

REFERENCE MATERIAL: GENERAL INDUSTRIES, pages 95-96, by Lindbeck and Lathrop,Charles A. Bennett, Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information

   A. Review the reference material

2. Teacher Presentation

   A. Discuss the etching process, its application in industry and its relationship to other materials.

   B. Demonstrate the etching process by completing the following procedures.*

      1. The article to be etched should be polished, buffed, and cleaned. Clean it be wiping with a soft colth dipped in lacquer thinner. Once the article has been etched, it should not be buffed again, as this will destroy the effect of the etching.

      2. Carefully transfer the design to the metal, using carbon paper and a firm pencil.

      3. Apply asphaltum varnish resist with a fine brush. Flow the material on so that everything is covered except the areas to be etched. Allow this to dry for 24 hours. Beeswax, plastic self-adhering wall paper, and masking tape may also be used as resist materials.

      4. Dip the article into the etching solution. For copper and brass, mix one part nitric acid with one part water. For aluminum, use one part muriatic (hydrocloric) acid and one part water.

         Always pour the acid into the water. Pouring water into acid is dangerous. There are safer etching solutions called mordants; mordants are available for etching most metals, and should be used whenever possible in the shop. Wear goggles, gloves, and a rubber apron when working with acids and mordants.

5. When the etching is deep enough, remove the article from the solution with plastic or wooden tongs. Rinse with water, and remove the resist. Asphaltum varnish can be removed with paint thinner, lacquer thinner, or turpentine. Gently rub the surface dry with a soft cloth.

3. Student Activity

   A. Allow each student to etch a piece of material by completing the procedures demonstrated.

* GENERAL INDUSTRY, Chapter 18, page 95-96, by John Lindback and Irvin Lathrop, Charles A. Bennett, Co.

PROCESS: SEPARATING, FORMING
& COMBINING
MATERIAL: METAL

ACTIVITY
"Films: Metal"

Allow 3 class periods

OBJECTIVE: At the completion of this activity the student will demonstrate his knowledge of the use and application of metal in industry by participating in the class discussion after viewing the films.

EQUIPMENT AND SUPPLIES NEEDED: 16mm projector

REFERENCE MATERIAL: Films: DRAMA OF METAL FORMING*
ONE HOLE FOR KALABO**
STORY OF PRODUCTIVITY***
WHAT'S IN THE MILL FOR YOU ****
MACHINES FOR MORE*****

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Preview the films.
   - B. Note key points in films.
2. Teacher Presentation
   - A. Discuss each film.
   - B. Ask questions over each film.
3. Student Activity
   - A. Participate in the disscussion of each film.
   - B. Answer questions proposed by the teachers.

*Shell Oil Co.
Film Library
450 N. Meridian St.
Indianapolis, Ia. 46204

**Modern Talking Picture Service, Inc.
3718 Broadway
Kansas City, Missouri

***Wilkie Brothers Found.
Film Department
254 N. Laurel Ave.
DesPlaines, Illinois 60016

****Republic Steel Corp.
Product Engineer Department
224 E. 131st St.
Cleveland, Ohio 44108

*****Bucyrus-Erie Company
Sales Promotion Department
P.O. Box 56
South Milwaukee, Wisconsin 53172

PROCESS: FORMING/CONDITIONING
MATERIAL: METAL

ACTIVITY
"Heat Treating Metal"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will know the affect of heating metal to various temperatures by conditioning sample pieces of steel.

EQUIPMENT AND SUPPLIES NEEDED: Ball pein hammer, Vise, old file, and heating equipment (oxy-acetylene torch, forge, etc.)

REFERENCE MATERIAL: GENERAL INDUSTRIES, pages 117-119, by Lindbeck and Lathrop, Charles A. Bennett, Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   A. Review the reference material.
2. Teacher Presentation
   A. Discuss the purpose of heat treating, its applications in industry and its relationship to other materials.
   B. Demonstrate the heat treatment process.
      1. Use a worn file.
      2. Heat the file to a temperature of approximately 1200 degrees F. and cool slowly.
      3. Reheat to 1600 degrees F. and cool in water--break end.
      4. Reheat to 2000 degrees F. and cool slowly--break end.
      5. Reheat to 2000 degrees F. and quench in oil--break end.
      6. Compare results and explain any differences observed.
3. Student Activity
   A. Students should observe the activity and ask pertinent questions. You may wish to have each student complete the process using different temperatures and different types of metal.

PROCESS: SEPARATING, FORMING
& COMBINING
MATERIAL: METALS

ACTIVITY
"Making a Candleholder"

Allow 4 class periods

OBJECTIVE: At the completion of this activity the student will have separated, combined, and formed metal as evidenced by the completed product (candleholder).

EQUIPMENT AND SUPPLIES NEEDED: Bench metal tools, band metal, flat black paint, welding rod, welder, grinder, and scroll bender

REFERENCE MATERIAL: GENERAL INDUSTRIES, pages 140-142, 146-147, 87-88, 93-94, 109-112, and 148, by Lindbeck and Lathrop, Charles A. Bennett, Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material.
2. Teacher Presentation
   - A. Discuss the product (candleholder) and the several processes to be completed.
   - B. Demonstrate the procedures for making the product.
     1. Design contemporary wrought iron candleholder.
     2. Separate pieces with hack saw and grind ends.
     3. Form pieces on scroll bender or vise as needed.
     4. Combine by welding as needed.
     5. Peen surfaces to obtain proper finish appearance.
     6. Paint surfaces.
3. Student Activity
   - A. Allow each student to complete a candleholder by completing the procedures demonstrated.

PROCESS: SEPARATING, FORMING
MATERIAL: METAL

ACTIVITY
"Forming a Cold Chisel"

Allow 3 class periods

OBJECTIVE: The student will demonstrate his knowledge of forging as a forming process by forging a cold chisel with in 3 class periods.

EQUIPMENT AND SUPPLIES NEEDED: Basic forging tools, files, black diamond chisel steel SAE 1080, 3/60, etc.

REFERENCE MATERIAL: GENERAL INDUSTRIES, pages 92-94, 117-119, by Lindbeck and Lathrop, Charles A. Bennett, Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material.
2. Teacher Presentation
   - A. Disscuss the forging process. Relate the process to other materials and to industry.
   - B. Provide the procedure for forging a chisel to each student.
3. Student Activity
   - A. Allow each student to form a chisel by:
     1. Forge blade to shape.
     2. File to good finish.
     3. Heat treat blade.
     4. Sand to a good finish.

PROCESS: SEPARATING, FORMING
MATERIAL: METAL

ACTIVITY
"Casting a Metal Product"

Allow 2 class periods

OBJECTIVE: At the completion of this activity the student will demonstrate his knowledge of casting as a forming process by casting an item with a permanent mold.

EQUIPMENT AND SUPPLIES NEEDED: Files, other finishing tools, lead or similar metal, and basic foundry equipment and furnace.

REFERENCE MATERIAL: GENERAL INDUSTRIES, pages 92-94, 113-116, by Lindbeck and Lathrop, Charles A. Bennett, Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
    - A. Review the reference material.
2. Teacher Presentation
    - A. Discuss the casting process, its application in industry and its relationship to other materials.
    - B. Demonstrate the activity.
3. Student Activity
    - A. Using the teacher furnished permanent mold (such as fish sinker mold or lead mallet mold, melt the metal, pour the metal and finish the casting.

PROCESS: SEPARATING, FORMING
MATERIAL: METAL

ACTIVITY
"Casting in a One-Shot Mold"

Allow 2 class periods

OBJECTIVE: The student will learn that coarse materials can be sifted from finer materials by performing a riddling operation and noting the fine texture of the sand which passes through the screen when compared to that remaining as evidenced by his answers to questions during the class period.

EQUIPMENT AND SUPPLIES NEEDED: Foundry pattern and tools, finishing tools (files), metal (lead or aluminum), paint, if desired, and melting furnace

REFERENCE MATERIAL: GENERAL INDUSTRIES, pages 92-94, 113-116, by Lindbeck and Lathrop,, Charles A. Bennett, Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
    A. Review the reference material.
2. Teacher Presentation
    A. Discuss molds, ramming up, sand texture, castings and patterns.
    B. Relate the casting process to plastics and earth products.
    C. Demonstrate how to ram up a mold by:
        1. Place pattern on mold board.
        2. Fill riddle with green sand or Petrobond and shake over pattern.
        3. Note fineness of sand as it is compacted against the pattern.
        4. Proceed to ram up one-piece mold.
        5. Prepare mold for casting.
        6. Shut down foundry oven, skim metal, and pour casting.
        7. After cooling, remove casting from sand and return sand to founder's bench.
        8. Finish casting.
3. Student Activity
    A. Allow each student to ram up a mold and cast a product by completing the procedure demonstrated.

PROCESS: FORMING
MATERIAL: METAL

ACTIVITY
"Metals Testing"

Allow 3 class periods

OBJECTIVE: At the completion of this activity the student will have a conceptual understanding of metals testing procedures as evidenced by participation in classroom discussion.

EQUIPMENT AND SUPPLIES NEEDED: Surface roughness gage, metal working vise, weld samples, surface finish roughness sample, surface finish metal samples, metal samples (wrought iron mild steel, tool steel, hihg carbon steel, hi-speed steel, manganese steel alloy) and grinder

REFERENCE MATERIAL: MACHINING FUNDAMENTALS, by Walker, Goodheart-Willcox Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information

   A. Review the reference material.

2. Teacher Presentation

   A. Discuss general metals characteristics classifying, identifying different metals and metal forms used by industry (an excellent information source is Goodheart-Willcox's MACHINING FUNDAMENTALS, by Walerk, pages 365-376.

   B. Demonstrate the identification of metals using the spark test. Teacher should supply unknown metal samples which students identify by spark test. Students should be given copies of chart on page 370 of reference cited above.

   C. Demonstrate hardness testing: Indention hardness testers, nonmarring testers, hardness number classifying system (an excellent information source is the reference cited above, pages 386-392).

   D. Demonstrate surface finish roughness inspection and quality control inspection. (see pages 395-398, 327-337 in above reference for information for presentation)

3. Student Activity

   A. Using a teacher-developed key, students may attempt to identify the type of machine process used to produce surface finishes on sample metal blocks. An alternate activity could be used involving a surface roughness gage and several sample surfaces. A third activity could be destructive testing of welded samples to determine quality of weld achieved.

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PROCESS: SEPARATING, FORMING,
& COMBINING
MATERIAL: WOOD

ACTIVITY
"Characteristics of Hardwoods & Softwoods"

Allow 2 class periods

OBJECTIVE: At the completion of this activity the student will be able to distinguish hardwoods from softwoods and understand the structure of hardwoods and softwoods as evidenced by instructor observed performance test.

EQUIPMENT AND SUPPLIES NEEDED: Magnifying glass or microscope, beaker of water, samples of red oak and yellow pine ¾" x ¾" x 3".

REFERENCE MATERIAL: GENERAL WOODWORKING, pages 292-293, Groneman
WOOD HANDBOOK, Handbook No. 72, U.S. Dept of Argiculture, pages 1-35

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   A. Review the reference material.
2. Teacher Presentation
   A. Discuss the characteristics of hardwoods and softwoods.
   B. Relate cell structure of wood to metal structure and plastic structure.
3. Student Activity
   A. Complete the following procedure on each piece of wood--red oak and yellow pine.
      1. Fill a beaker about 2/3 full of water.
      2. Immerse one end of a red oak sample in the water.
      3. Place your mouth over the dry end of the sample and blow.
      4. Repeat steps 2 and 3, using the sample of yellow pine.
      5. Examine closely the dry end of each sample using a magnifying glass or a microscope.

   B. Complete the following
      1. Describe what you observed through the magnifying glass or microscope. Compare your sample of what you see with your teachers sample or consult GENERAL WOODWORKING, by Groneman, Unit 64, page 286, Fig. 63-2.
      2. Which sample permitted the greatest amount of air to flow through the sample.
      3. What part of the wood did the air flow through?
      4. How can hardwoods and softwoods be identified?

PROCESS: SEPARATING
MATERIAL: WOODS

ACTIVITY
"Sawing: Chip Removal"

Allow 2 class periods

OBJECTIVE: At the completion of this activity the student will understand separating by sawing and making 12 different cuts on lumber prepared by the teacher.

EQUIPMENT AND SUPPLIES NEEDED: Coping, hand (crosscut, rip), back, keyhole, compass wood, Saws--table, band, radial, scroll, "jig" saw

REFERENCE MATERIAL:

PROCEDURE FOR THE ACTIVITY

1. Teacher Presentation.
   - A. Explain each sawing operation. Refer student to textbooks for further information. Discuss the separating process as related to metals, plastics and earth products.
   - B. Demonstrate the operation of equipment, safety procedures, etc.
2. Student Activity
   - A. Allow each student to experience every sawing operation.

PROCESS: SEPARATING, COMBINING
MATERIAL: WOOD

ACTIVITY
"Drilling, Boring, Planing, Sawing, Bonding, and Finishing

Allow 5 class periods

OBJECTIVE: At the completion of this activity the student will demonstrate his knowledge of separating and combining processes by the completion of the teacher selected project.

EQUIPMENT AND SUPPLIES NEEDED: Brush, polyvinyl, brushing lacquer, woodworking machines, selected stock.

REFERENCE MATERIAL: INDUSTRIAL ARTS WOODWORKING, by Frier, Charles Bennet Pub. Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information

   A. This activity is designed to allow each student to build a project--a project which the teacher selects and which incorporates several separating and combining processes. Plans of the project should be distributed to each student. You may desire to have the students complete a list of each process required to complete the project. An example of a project which might include these processes is listed on page 390 of INDUSTRIAL ART WOODWORKING, Frier, Charles A. Bennett Co.

2. Student Activity

   A. Allow each student to custom produce the teacher selected project.

PROCESS: COMBINING
MATERIAL: WOOD

ACTIVITY
"Flocking"

Allow 1 class period

OBJECTIVE: At the completion of this activity, students will understand the flocking (combining) process as evidenced by their ability to apply flock with a gun or by hand.

EQUIPMENT AND SUPPLIES NEEDED: Felt, glue, stock (wood, metal, plastic), brush, felt gun

REFERENCE MATERIAL:

PROCEDURE FOR THE ACTIVITY

1. Teacher Information

   A. Flocking consists of applying powdered felt over glue, thus making a felt surface. Each piece of felt has negative and positive poles causing the felt to stand on end.

2. Teacher Presentation

   A. Discuss the flocking process. Provide examples of industrial applications of the process.

   B. Demonstrate the process by completing the listed procedure.

      1. Surface must be dry and moderatly smooth.
      2. Apply a liberal amount of glue on surface.
      3. Spray flock on glue.
      4. Allow flocked surface to dry for 24 hours.
      5. Observe position of flock with a magnifying glass.

3. Student Activity

   A. Allow each student to apply flock by completing the procedures demonstrated.

PROCESS: SEPARATING
MATERIAL: WOOD

ACTIVITY
"Shearing and Chip Removal"

Allow 2 class periods

OBJECTIVE: At the completion of this activity students will demonstrate an understanding of how stock is sheared by the completing of the activity.

EQUIPMENT AND SUPPLIES NEEDED: Sample stock, wood lathe, tools and accessories

REFERENCE MATERIAL: WOODWORKING FOR INDUSTRY, pages 289-291, by Feirer, Charles A. Bennett, Co. included

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material.
   - B. Discuss the separating process. Note that veneer is made by a shearing process.
   - C. Relate the separating process to plastics and metal materials.
2. Teacher Presentation
   - A. Demonstrate the process by following the procedures provided in the reference material.
3. Student Activity
   - A. Allow each student to experience the process by completing the procedure demonstrated.

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WOODWORKING FOR INDUSTRY, pages 289-291, Feirer

Spindle Turning:

Spindle turning is done with the work held between the live (or moving) center and dead (or non-moving) center. This includes straight turning making shouldercuts, cutting tapers, and cutting convex and concave surfaces and grooves.

1. Select the correct kind of wood, slightly larger than the diameter to be turned and 1" longer than needed. If the stock is larger than 3" square, cut it to an octagon shape on the band saw.

2. Draw lines diagonally across the ends. The intersection of the lines is the approximate center.

3. Mark the center with a prick punch or scratch awl. If the wood is extremely hard, drill a small hole at the center and cut shallow saw kerfs across the corners.

4. With a spur center in position over one end of the stock, strike it several times with a mallet to drive it into the wood. Now, place the stock over the spur center. Move the tail stock to about ¼" from the end and clamp it to the bed. Turn the tail stock spindle until the cup center is seated in the center hole at the end of the stock. Then release the pressure and apply a little beeswax or oil. Re-tighten the tail stock until there is a little tension on the hand wheel, and then lock it in position.

5. Move the tool rest to within 1/8" of the work, with the top of the rest about 1/8" above the center. If the stock is quite long, adjust the tool rest with one end even with the tail stock end of the stock.

6. If the stock is from 1" to 2" in diameter, use the fastest speed; from 2" to 3", one of the middle speeds; above 3", the slowest speed.

7. Turn the lathe over by hand once or twice to make sure everything clears.

8. Use the gouge to cut or scrape the stock to a cylinder shape. Hold the gouge blade securely in the left hand and the handle in the right hand. Steady the gouge with the left hand by placing the heel of the palm against the front of the tool rest. Hold the palm on top of the tool for heavy, and under tool for fine cutting. To cut with a gouge, bring the turning tool against the wood and twist it slightly to the right, forcing it into the revolving stock until the cutting begins. The beveled edge should be tangent to the cylinder. Then move the tool slowly towards the tail stock. After each cut, move the gouge several inches more toward the headstock and repeat. When the cylinder is formed to within about 2" of the headstock, twist the tool to the left and push it toward the headstock. Continue to cut until a cylinder is shaped. Check the diameter frequently with a caliper that is set about 1/8" over finished diameter. Move the tool rest as the work progresses, keeping about 1/8" clearance.

PROCESS: FORMING, COMBINING
MATERIAL: WOOD

ACTIVITY
"Bonding, Bending, & Laminating"

Allow 2 class periods

OBJECTIVE: At the completion of this activity the student will demonstrate his knowledge of forming by laminating a fork and spoon.

EQUIPMENT AND SUPPLIES NEEDED: Clamps, utility knives, veneer, glue, molds, band saw, and circular saw

REFERENCE MATERIAL: GENERAL WOODWORKING, page 114, by, Groneman, McGraw-Hill, 4th edition
Film: THE WOOD THAT COULD

1. Teacher Information
   - A. Review the reference material.
   - B. Preview the film.
2. Teacher Presentation
   - A. Show the film.
   - B. Discuss the laminating process. Relate lamination's application to the building construction trades. Relate the process to metals and plastic bonding and bending.
   - C. Demonstrate the laminating process by completing the following procedures.
     1. Make a salad fork mold of the desired shape. A piece of stock 2" x 4" x 12" proves appropriate for the mold.
     2. Cut veneer to width and length. Standard veneer stock may be purchased commercially.
     3. Apply a thin coat of glue to one or both veneer surfaces to be joined. Be sure to place wax paper between the laminated stock and the mold, or form.
     4. Apply glue on all veneer surfaces to be bent. Veneer may be added until the desired thickness is achieved.
     5. Place the laminating material between the forms. Place the mold in clamps and tighten.
     6. Allow adhesive to dry. Trim stock with band saw or sander.
     7. Apply a vegetable oil finish.
3. Student Activity
   - A. Allow each student to laminate a salad fork and spoon by completing the procedures demonstrated.

PROCESS: FORMING, CONDITIONING
MATERIAL: WOOD

ACTIVITY
"Curing"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will understand "curing" by kiln drying a piece of wood.

EQUIPMENT AND SUPPLIES NEEDED: Green wood and oven

REFERENCE MATERIAL: WOODWORKING FOR INDUSTRY, pages 104-106, Feirer, Charles A. Bennett, Co. Included

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material.
2. Teacher Presentation
   - A. Discuss the conditioning process. Relate the process to metals and plastic conditioning processes.
   - B. Demonstrate the process by completing the procedures listed.
     1. Cut two specimens of stock the same width and length.
     2. Weigh both specimens on scale graduated to 1/100 part of a gram.
     3. Dry specimens in electric oven at 210 degrees to 220F. degrees or until bone dry.
     4. Re-weigh specimens and compare weight of both specimen.
     5. Kiln dried lumber has a moisture content of 6 to 12%.
3. Student Activity
   - A. Allow each student to kiln dry a species of lumber by completing the procedures demonstrated.

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WOODWORKING FOR INDUSTRY, Feirer

Methods of Drying Lumber

Wood increases in strength, hardness, and stiffness as it dries. There are two common methods of drying lumber: namely, air drying and kiln drying. Both are entirely satisfactory depending on the particular use for the lumber. For some purposes lumber is first air dried and then kiln dried. In other cases it is all air dried or all kiln dried.

In air drying or seasoning, rough lumber is stacked in layers with crossers or spacers between, so that air can circulate freely. Circulating air performs three functions:
It carries heat to the lumber pile to aid evaporation.
It carries the moisture out of the pile as the water evaporates.

It breaks up the film of still air that surrounds each board, thus reducing the humidity at that point and helping to remove more of the water vapor from the wood.

Important factors in proper air drying are the location of the air drying yard, the method of stacking the lumber, and the problems of temperature, humidity, and wind. After exposure to air for an adequate length of time, usually from one to three months, the moisture content of wood should be a minimum of about 12 to 15 percent. Lumber at 20 percent or less is immune to decay.

In kiln drying, lumber is stacked in piles and placed in a kiln (oven) in which air volume and temperature are carefully controlled. Here the moisture content of the lumber is reduced to a specified amount. The advantages of kiln drying are:
Moisture content can be reduced to a definite amount and can be lowered farther than through air drying.
Kiln drying takes a much shorter time than air drying.
Kiln drying tends to kill decay fungi and insects in the wood.
If properly done, kiln drying usually results in fewer imperfections than does air drying.

In this procedure, steam is usually sprayed on the lumber to moisten it uniformly and then it is dried until the moisture content is about 4 to 12 percent. Green, one-inch lumber can be dried to 6 to 12 percent in three or four days in modern kiln. Moisture content can be checked during the drying process with a moisture meter. In both kinds of drying. seasoning causes some defects that downgrade the quality of the lumber. Among the most common are checks, honey combs, warps, loosening of knots, and cracks caused by unequal shrinkage. Drying lumber too rapidly or too much causes checking and splitting. Construction lumber is usually dried to about 12 to 19 percent.

PROCESS: COMBINING, CONDITIONING
MATERIAL: WOOD

ACTIVITY
"Bleaching with Ammonia"

Allow 2 class periods

OBJECTIVE: At the completion of this activity the student will understand the bleaching of wood as evidenced by bleaching a sample product.

EQUIPMENT AND SUPPLIES NEEDED: Ammonia (16 Baum), plastic bag, and sample stock

REFERENCE MATERIAL:

PROCEDURE FOR THE ACTIVITY

1. Teacher Presentation
    - A. Discuss the effects of chemicals on various materials. Note safety procedures for working with chemicals.
    - B. Discuss the combining of chemicals with materials, the conditioning of material with chemicals (cresote), and forming of materials with chemicals (anhydrous ammonia).
    - C. Relate chemical processing to metals and plastics.
    - D. Demonstrate the bleaching process by completing the following:
        1. Place a wood sample in a plastic bag with a small amount of ammonia. Observe. Cherry wood should produce easily recognizable results.
        2. Allow the wood and ammonia to remain in the container until the material becomes bleached.

PROCESS: COMBINING, CONDITIONING
MATERIAL: WOOD

ACTIVITY
"Dyeing--Bleaching"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will demonstrate an understanding of bleaching wood by bleaching a sample product.

EQUIPMENT AND SUPPLIES NEEDED: No. 1 and No. 2 bleach, sample stock, face shield, swab, gloves, apron

REFERENCE MATERIAL: WOODWORKING FOR INDUSTRY, page 600, by Feirer, Charles A. Bennett, Co. included

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material.
2. Teacher Presentation
   - A. Discuss the bleaching process and its relation to industry.
   - B. Demonstrate the process by completing the following procedure.
     1. Dress appropriately--face shield, gloves and apron.
     2. Mix the commercial bleach as indicated on containers and follow the directions printed on the container.
     3. Apply the bleach to the surface with a sponge or rope brush. Work from the top down.
     4. Rinse the bleached surface with a 50-50 solution of water and white vinegar.
     5. Allow bleached surface to dry for 12 hours.
     6. Sand the surface lightly with 6/0 garnet paper and felt pad.
     7. Note: Keep all bleaching rags in a closed metal container.
3. Student Activity
   - A. Allow each student to bleach a piece of wood by completing the procedures demonstrated.

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WOODWORKING FOR INDUSTRY, page 600, Feirer

BLEACHING:

Bleaching is a process of removing color from wood in order to obtain a full-blond effect. For simple bleaching operations, oxalic-acid crystals dissolved in hot water are satisfactory. However, for a more involved bleaching process, a commercial bleach will usually give better results.

Always follow the directions printed on the container. Apply the bleach to the surface with a sponge or rope brush, and work from the top down. Rinse the bleached surface with a 50-50 solution of water and white vinegar. Then allow it to dry for 12 hours. Sand the surface lightly with 6/0 garnet paper. Keep all bleaching rags in a closed metal container.

PROCESS: COMBINING
MATERIAL: WOOD

ACTIVITY
"Adhesion and Cohesion"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will understand how unlike materials can be welded as evidenced by the completion of sample products.

EQUIPMENT AND SUPPLIES NEEDED: Wood, plastic, glass, metals, hot glue gun, and adhesives

REFERENCE MATERIAL: GENERAL WOODWORKING, pages 321-322, Groneman, McGraw-Hill

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material.
2. Teacher Presentation
   - A. Discuss the combining of various types of materials by the adhesion and cohesion process.
   - B. Discuss the chemical reactions of various adhesives to different materials.
3. Student Activity
   - A. Allow each student to glue several pieces of wood, plastic, metal and glass together. Do tests re: sheer, stress, etc. Students should consult various books that define glue and adhesives. Experiments may be conducted on the various glues and adhesives. Some of the items students can test on various glues and adhesives are hardness, weight, freedom from shrinking and swelling, and moisture content.

PROCESS: COMBINING
MATERIAL: WOOD

ACTIVITY
"Bonding with Contact Cement"

Allow 1 class period

OBJECTIVE: At the completion of this activity the students will demonstrate an understanding of how materials are bonded by adhesion with contact cement by completing the sample product.

EQUIPMENT AND SUPPLIES NEEDED: Contact cement, two pieces of wood, brush, and thinner

REFERENCE MATERIAL:

PROCEDURE FOR THE ACTIVITY

1. Teacher Presentation

   A. Discuss the bonding process and relate the process to metals, woods, plastics, and earth materials.

2. Student Activity

   Allow the students to bond two pieces of wood by completing the following procedure.

   1. Adhesive is applied to both surfaces and allowed to dry.
   2. Cement is dry when it does not stick to the fingers.
   3. When surfaces are brought into contact the bond is immediate and therefore no clamping, nailing, or holding down is required.
   4. Clean tools and equipment with contact cement solvent or water, depending upon the type of cement used.

PROCESS: COMBINING
MATERIAL: WOOD

ACTIVITY
"Staining"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will demonstrate an understanding of applying stain as evidenced by the completed sample or product.

EQUIPMENT AND SUPPLIES NEEDED: Mixing container, stirring rod, stain and finsh, and sample stock

REFERENCE MATERIAL: GENERAL WOODWORKING, 4th edition, Groneman, McGraw-Hill Co., pages 238-239

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material
   - B. Staining provides an undertone color for a finish, or changes the tone or shade of the surface. Two types of fine-powdered substances provide the color in stains. They are soluble colors or dyes, which are dissolved in the stain, and insoluble pigment colors, which are dispersed in the stain but not dissolved. The soluble colors penetrate into the wood pores and actually make the color a part of the wood, while the insoluble colors remain on the surface, providing a uniform appearance. Some of the more common kinds of stains are: water stain, non-grain-raising stains (NGR), spirit stains, oil stains and pigment oil stains.
2. Teacher Presentation
   - A. Discuss the combining process and relate the process to metals, plastics, and earth products.
   - B. Demonstrate the process by completing the procedure listed in the reference material.
3. Student Activity
   - A. Allow each student to stain a piece of wood by completing the procedures demonstrated.

PROCESS: COMBINING, CONDITIONING
MATERIAL: WOOD

ACTIVITY
"Finishing by Spraying"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will demonstrate his understanding of combining by using the spray gun to apply finish to a product.

EQUIPMENT AND SUPPLIES NEEDED: Lacquer, lacquer thinner, spray gun/equipment

REFERENCE MATERIAL: GENERAL WOODWORKING, Groneman, 4th Edition, McGraw-Hill Book Co.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material
2. Teacher Presentation
   - A. Discuss the spraying process, the equipment and the industrial applications of the process. Relate the process to other materials.
   - B. Demonstrate the process by completing the procedures listed in the reference material.
3. Student Activity
   - A. Allow each student to apply a finish to a piece of wood by completing the procedure demonstrated.

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PROCESS: SEPARATING, FORMING,
& COMBINING
MATERIAL: CERAMICS

ACTIVITY
"Making a Ceramic Plate"

Allow 2 class periods

OBJECTIVE: At the completion of this activity the student will demonstrate his knowledge of how ceramic products are made by various processes to make a small ceramic plate.

EQUIPMENT AND SUPPLIES NEEDED: Kiln, sprayer, and spray booth

REFERENCE MATERIAL: ACTIVITIES IN CERAMICS, by Thompson, McKnight-McKnight Pub. Co. included

PROCEDURE FOR THE ACTIVITY

1. Teacher Information

   A. Review the reference material.

2. Teacher Presentation

   A. Conduct a class discussion about the various methods of processing ceramic material. These processes are all related to the processing of various other materials. The student will complete 6 methods of processing in the completion of the product.

   B. Demonstrate the process by following the procedures below.

      1. Place a ball of clay on the oil cloth and pound it down with the heel of your hand until it is one inch thick. (this pounding the clay removes air bubbles)

      2. Place two guide sticks beside the clay and roll it out to even thickness, (¼" thick) using rolling pin. Keep the rolling pin wet by wiping it with a cloth. (Rolling Process)

      3. Cut out around the clay using an old plate for a pattern. Use fettling knife. (Shearing Process)

      4. Wet a piece of jersey cloth and wring out the excess water. Stretch it evenly but lightly over the plate and gather the excess cloth under the bottom of the plate.

      5. Lay the slab of clay on the cloth covered plate.

      6. Using a circular motion, gently push the clay into the form of the plate with a damp sponge.

7. Set the formed slab aside to dry. Place it in a warm oven or oven radiator to harden the first part of the drying.

8. Remove from the plate.

9. Decorate the plate by glazing using either brush, dipping or spray method.

10. Stir glaze thoroughly.

11. Apply glaze with a brush, spray or dipping

12. Let dry.

13. Place piece in kiln.

14. Firing temperature may vary a great deal, depending upon the type of clay, the use of the finished piece, and the glaze to be applied.

Plates may be made by several different methods: by slip casting, press molding, pinching, or by the piecrust method. The piecrust method is best and easiest. The plates are very strong and they have that "hand made" look which many people prefer.

3. Student Activity

A. Allow each student to complete a plate by following the procedures demonstrated.

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ACTIVITIES IN CERAMICS, by Seeley Thompson

Glazing--page 44

Glaze is the glass-like substance which is fused onto the surface of clay in the heat of the kiln. The purposes of glazing are to make clay waterproof, durable, and decorative. Beginners should not anticipate immediate professional results; much practice and experimentation are required to master the many highly specialized techniques of glazing.

There are available to the modern ceramicist numerous specially manufactured glazes which will accommodate nearly all of the problems of coloring and decorating one is apt to meet in everyday work. There are special glazes for brushing, spraying, dipping, and pouring, each with special characteristics which govern their use.

Glazes may be purchased in ready-mixed form or as powders which may be mixed in the workshop to suit individual problems. Ready-mixed glazes are becoming more popular with beginners, however, because they are available in such an abundant variety of color and are comparatively easy to use. Manufacturers' recommendations should be followed very carefully in all cases.

Brushing Glaze--page 45

Brushing is the easiest method of applying glaze and the one most often used by beginners. Particularly in situations where several people are working together, brushed-on glazes have several distinct advantages: Only a small amount of glaze is necessary, there is little or no waste, there are no irritating fumes or dust, and combinations of many colors may be applied to a single piece. Pieces which have brushed-on glazes applied may be handled easily without damage to prepared glazed surfaces, unlike pieces glazed by other techniques. Many brushed-on glazes may be used on greenware as well as bisque.

Brushed-on glazes also contain a gum solution which is designed to keep the glaze in suspension. The gum slows absorption as the glaze is being applied. Glazes which do not contain gum are very difficult to apply because they tend to "pile" during application.

Tools and Materials

A good ox hair brush at least one-half inch wide and brush-on glaze.

Procedure

1. Stir the glaze thoroughly.
2. Using a full brush of glaze, flow the glaze onto the surface of the piece. Cover the entire piece.
3. Apply a second coat after the first coat is thoroughly dry. Drying will take only a few minutes.
4. If a colored glaze is used, give the piece a third coat of glaze. When using clear glaze, two coats are usually sufficient. Most failures result from applying too little glaze. A colored glaze coating should be approximately one-sixteenth (1/16) of an inch thick on the piece; clear glaze should be about one-thirty-

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second (1/32) of an inch thick.

5. The piece may be glost fired immediately or stored to be fired later.

If, after firing, the glaze is too thin, more glaze may be applied to the thin spots and the piece fired again. A few sample pieces will soon show just how much glaze needs to be applied. No set rule can be given. Each glaze has its own special characteristics. Follow each manufacturer's recommendations carefully.

Unusual effects can be obtained by applying a second or third coat in contrasting color. There are unlimited possibilities using this technique.

Note: Brushed-on glazes may be made from any dry powdered glaze by proper mixing of glaze, gum, and water. The amount of gum varies with different glazes, but with a little experimenting the proper proportions are easy to develop. Mix the dry glaze with just enough water to make a thick paste. Mix thoroughly; eliminate all lumps. Next add enough gum to make a thick, creamy liquid. Test this on a bisque piece. If it brushes on smoothly, it is ready to use. If it is gritty or piles on the surface of the ware, add more gum and mix again.

Most commercial glaze manufacturers combine the gum and other ingredients before milling. This procedure assures a very smooth mixture. The same smoothness may be acquired in the ceramic workshop by grinding the glaze and gum together in a mortar and pestal. There are many types of gum on the market; any ceramic manufacturer can supply you with them. Be sure to follow the manufacturer's instructions when preparing the gum.

Spraying Glaze--page 46

Spraying is another easy-to-learn method of applying glaze. The techniques are very simple and easy to control. Because of the toxic nature of most glazes, however, a spray booth and mask always should be used.

Tools and Materials

Sprayer, spray booth, mask, bench whirler, paper, and glaze.

Procedure

1. Mix the glaze to about the consistency of thick cream.
2. Place the piece to be glazed on the whirler in the spray cabinet. Put a piece of newspaper or a paper towel under the piece to absorb excess glaze and keep it from piling on the bottom of the piece.
3. Adjust the sprayer nozzle to a fine spray. If there is a pressure gauge on the sprayer, adjust it to about 20 pounds pressure.
4. Rotate the piece slowly while spraying. At first, hold the spray quite close to the piece. As the coat becomes heavier, hold it further away. Be sure to get the glaze into all cracks and crevices. The top and under side needs special attention. It is sometimes necessary to hold the piece in your hands to get at the top and bottom.

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Spraying Glaze continued

5. When the piece begins to look pebbly, there is probably sufficient glaze on it. Most beginners fail to get enough glaze on the piece, seldom do they get too much.

Watch carefully to see that the glaze does not begin to run as it is being sprayed. It should be sprayed on slowly enough so that the ware can absorb the glaze. Should the glaze begin to run, put the piece aside and allow it to dry before continuing.

Often a combination of methods may be used for glazing. Unusual and interesting effects may result from spraying a light coat of a dark-colored glaze over a heavy coat of light-colored glaze. Areas may be shaded or entirely blocked out, or contrasting colors may be applied with a sponge over an already-glazed surface. Many air-brush painting techniques are used successfully.

Dipping Glaze--page 47

One of the most efficient ways of applying glaze is dipping, since the ware will absorb an even amount throughout if the glaze is of the proper consistency. The consistency depends upon the porosity of the ware and the ability of the ware to absorb the glaze. Dense pieces will require heavier glazes. Many potters use hydrometers to test the density of glazes. As a general rule, follow the manufacturer's recommendations carefully.

Tools and Materials

Large glass or stone jar, sufficient glaze, and a small brush for touching up finger marks.

Procedure

1. Submerge the piece completely and remove it immediately. Small pieces may be held successfully with a pair of metal tongs while being dipped.
2. Touch up any spots that may have been missed or marks left by the fingers. Use the small brush for this purpose.
3. Excess glaze should be sponged or scraped from the bottom of the piece to keep it from running down the stilts during the glost fire.
4. Put the piece aside to dry.

Pieces which have remained around the shop for any length of time should be thoroughly cleaned with a moist sponge before glazing.

The Bisque Fire--pages 61 & 62

After clay has been formed into a desired shape, it is necessary to drive off all physical and chemical water to make it durable. This is done in the heat of the kiln. The clay is heated to a red heat or gotter and approaches the vitrifying point, or the temperature at which any particular clay fuses. A chemical change takes place during firing which completely changes the properties of clay. It becomes a ceramic product. Once clay has been fired, it cannot be changed back to plastic clay. It becomes hard, durable, and has deveolped a receptive surface for decorating and glazing.

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Be sure all ware is thoroughly dry before placing it in the kiln. Drying may take from a day to several weeks, depending on the size of the piece and the atmospheric conditions.

When a kiln is packed with modeled pieces, it should be turned on "low" for an hour or two, then on "medium" for a few hours or until the pyrometer reads about 1000 degrees Fahrenheit. The peep holes should be left open and the door "cracked" about one-half inch during this period of the firing to allow moisture to escape. It is during this part of the firing that the physical water is driven off in the form of steam. If this water is driven off too rapidly, however, the piece is apt to "blow."

Hand-modeled pieces over one inch in thickness should be hollowed out. If it is impossible to hollow out a large piece, pierce holes in it with a needle or lace tools. These holes will allow steam to escape more rapidly and help prevent blowing.

In packing the bisque kiln, greenware may be placed directly on the bottom or on the shelves of the kiln. No stilts are necessary. All pieces should be placed so that there is good circulation of air about them, and so they will not warp during firing. One piece may be placed on top of another if the weight will not cause warping during the fire. Boxes should be fired with covers on so they will not warp out of shape.

It is best to fire large pieces very slowly. Low fired clays are usually bisque fired to about cone 06, or about 1850 degrees Fahrenheit. Firing temperatures may vary a great deal, however, depending upon the type of clay, the use of the finished piece, and the glaze to be applied. If the pieces are not to be glazed, the kiln should be fired to cone 04. If the pieces are to be glazed by spraying and refired to a maturing temperature, it will not be necessary to fire the bisque beyond 1800 degrees. A lower temperature will allow the piece to absorb glaze more readily.

With some types of clays and glazes it is unnecessary to fire the greenware. Glaze may be applied and the piece completed in one firing. Many commercial firms use this one-fire process to cut down operating costs and speed up production. When this is done, great care must be taken in handling the pieces.

In general, bisque and glazed pieces should not be fired together. If a piece of greenware should blow while in a kiln with pieces being glazed, particles of clay might be deposited on the glazed pieces and ruin them. This danger does not exist when glazed pieces are fired by themselves. The cast pieces do not offer so much danger of blowing. If it is necessary to put a glazed piece in a bisque kiln, try to place the glazed piece on the upper shelf away from any heavy pieces.

A pyrometer or pyrometric cones are used to check the progress of the firing. For example, if the kiln is to be fired to cone 06, or about 1850 degrees F., cones 07, 06, and 05 are placed in a pat of clay or held in a cone holder, with the cones inclined slightly from the perpendicular. Cone 07 matures at the lower temperature and will deform first. It must be placed so it will fall away from cone 06 as it melts. The cones are placed in the kiln so they may be viewed thru the peep hole. When cone 06 deforms the ware is properly fired and the kiln should be turned off immediately. If cone 05 is deformed the kiln has been overfired for that clay.

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Bisque Fire continued

When the bisque kiln has reached the maturing temperature, it may be turned off and allowed to cool. A pyrometer is often used along with or in place of the cones. If a pyrometer is used instead of the cones, it should be checked frequently with cones to see that it registers properly. Cones measure the maturity of the clay, a pyrometer measures the temperature of the kiln. The kiln door may be "cracked" a little to hasten the cooling process. Do not open the door too wide; a cold draft of air will crack hot bisqued pieces.

When the pieces are removed from the kiln, they should be kept in a clean, dry place until they are ready for decorating or glazing. If bisque pieces are handled often or allowed to gather dust, glaze problems will develop ~~later~~.

Figure 109 gives the approximate temperature equivalents of the pyrometric cones produced by one large manufacturer. These temperature equivalents are average values obtained when the rate of temperature rise was as indicated at the top of the column--and this rate maintained during the last several hundred degrees. However, only seldom will the kiln conditions and firing rates match those upon which the table is based. The table is a good temperature guide for the user of cones and will be helpful on many occasions. It is included here for that reason.

TABLE OF TEMPERATURE EQUIVALENTS ORTON STANDARD PYROMETRIC CONES

cone			large cones	
number	(1)60°C	108°F	150°C	270°F
022	585°C	1085°F	600°C	1112°F
021	602	1116	614	1137
020	625	1157	635	1175
019	668	1234	683	1261
018	696	1285	717	1323
017	727	1341	747	1377
016	767	1407	792	1458
015	790	1454	804	1479
014	834	1533	838	1540
013	869	1596	852	1566
012	866	1591	884	1623
011	886	1627	894	1641
010	887	1629	894	1641
09	915	1679	923	1693
08	945	1733	955	1751
07	973	1783	984	1803
06	991	1816	999	1830
05	1031	1888	1046	1915
04	1050	1922	1060	1940
3	1086	1987	1101	2014
02	1101	2014	1120	2048
01	1117	2043	1137	2079
1	1136	2077	1154	2109

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2	1142	2088	1162	2124
3	1152	2106	1168	2134
4	1168	2134	1186	2167
5	1177	2151	1196	2185
6	1201	2194	1222	2232
7	1215	2219	1240	2264
8	1236	2257	1263	2305
9	1260	2300	1280	2336
10	1285	2345	1305	2381
11	1294	2361	1315	2399
12	1306	2883	1326	2419

Fig. 109. Temperature equivalents of Pyrometric Cones

(1) The rate of heating up the cones during the last several hundred degrees of the tests.

Note 1. All temperature equivalent values given in °C are average values as determined at the National Bureau of Standards and were measured at the time that the tip of the cone touched the plaque. All temperatures given in °F were calculated by the use of the following: equation: °F = 1.8 x °C +32. Temperature equivalents were not determined for small cones Nos. 022, 014, 013, 012, and 011. The temperature equivalent values in °C shown in the table (except as noted) were determined by Henry P. Beerman, Research Associate, at the National Bureau of Standards for the Edward Orton Jr. Ceramic Foundation.

Note 2. The temperature equivalent values given in this table apply only to Orton Standard Pyrometric Cones when heated in an air atmosphere at the rate of heating shown. The temperature equivalent values are furnished for information purposes only. They are not necessarily the temperature actually in a furnace at the time when the cone goes down.

PROCESS: FORMING
MATERIAL: CERAMICS

ACTIVITY
"Extrusion Molding–Ceramic"

Allow 1 class period

OBJECTIVE: At the completion of this module the student will have made a ceramic string by the extrusion process and know that the same process will also produce parts of metal, plastic and other materials if applied under the proper conditions, as evidenced by the finished product and answering the questions related to the activity.

EQUIPMENT AND SUPPLIES NEEDED: Extrusion, press, ceramic powder or pre-mixed slurry, a hanging hook, water and oil for cleaning up and oiling the dye.

REFERENCE MATERIAL:

PROCEDURE FOR THE ACTIVITY

1. Teacher Presentation
   - A. Discuss extrusion molding. Relate the process to metals, plastics and earth products.
   - B. Demonstrate the extrusion of ceramic material by completing the following procedures.
     1. Obtain the die. Place the die on the press.
     2. Obtain ceramic material and mix to a consistency of concrete which will slump about ½.
     3. Place about one teaspoonful of ceramic into die.
     4. Press out 1/8" diameter and several inches long piece of ceramic "spaghetti"
     5. Very carefully break "spaghetti" loose from dye and hang it up to dry.
     6. The ceramic may take from one day to one week to dry to a very stiff consistency. Check each day, but go on to another activity while waiting.
   - C. The 'string' will be used in the next activity.
2. Student Activity
   - A. Allow each student to extrude a 'string' by completing the procedure demonstrated.
   - B. Answer 5 teacher prepared questions about the extruding process.

PROCESS: COMBINING
MATERIAL: CERAMICS

ACTIVITY
"Carbon Coat Ceramic"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will understand that carbon can be deposited on a non-conducting surface to make an electrical resistor by making a resistor.

EQUIPMENT AND SUPPLIES NEEDED: Oxy-acetylene welding torch, Ohm meter.

REFERENCE MATERIAL:

PROCEDURE FOR THE ACTIVITY

1. Teacher Presentation

   A. Discuss electrical uses for earth products (ceramics).

   B. Demonstrate carbon coating ceramics by completing the following procedures.

      1. Break off a piece of the ceramic spaghetti about 1" long and check it for electrical resistance.

      2. If it conducts electricity to give less than 100,000 ohms resistance, warm it with a torch very gently to dry it out.

      3. Adjust the torch to a carburizing (slightly smokey) flame and heat the ceramic rod to give it a carbon coating thick enough to turn it black.

      4. Measure the resistance of the resistor which you have just made and determine the resistance you would like to have in your finished resistor.

      5. Rub the resistor with your finger tip, a cloth, an eraser, or a very fine piece of emery cloth until it has the desired resistance within 10%.

      6. The finished product is a resistor as used in radios, TVs, and other electrical devices.

2. Student Activity

   A. Allow each student to make a resistor by completing the procedure as demonstrated.

PROCESS: FORMING
MATERIAL: CERAMICS

ACTIVITY
"Spinning Ceramics"

Allow 1 class period

OBJECTIVE: At the completion of this activity the student will understand ceramic spinning by spinning a ceramic bowl.

EQUIPMENT AND SUPPLIES NEEDED: Water, clay, cutting tools, wedging, and potter wheel

REFERENCE MATERIAL: ACTIVITIES IN CERAMICS, page 36, by Thompson, McKnight & McKnight Pub. Co. included

PROCEDURE FOR THE ACTIVITY

1. Teacher Information
   - A. Review the reference material.
2. Teacher Presentation
   - A. Discuss the spinning of metal ceramics, wood and plastics. Relate the processes to industrial applications.
   - B. Demonstrate the spinning of ceramics by completing the following procedures.
     1. Thoroughly wedge a lump of clay about the size of a softball. Kneed the clay after every few cuts.
     2. Lump the clay into a ball and throw it down on the wheel head as near the center as possible.
     3. Center the clay by forcing the ball of clay into the exact center of the wheel.
     4. Hold the left hand rigid and force the clay against it with the fingers of the right hand.
     5. Downward pressure must be applied with the heel of the left hand to keep the clay from loosening and coming off the head.
     6. Keep hand wet at all times.
     7. When clay is soft and pliable, open the center with the thumb.
     8. Draw the clay into a cylinder with the knuckles.
     9. Form the piece with your hand.

10. Cut the top off even with a sharp cutting instrument.
11. Form a spout if necessary.
12. Put aside to dry.
13. Glaze it.
14. Fire after glaze is dry.

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ACTIVITIES IN CERAMICS, page 36, by Thompson

For many centuries the romantic symbol of the ceramic arts has been the potter's wheel. The wheel is almost as old as the art itself. Its origins are uncertain, but its use developed with nearly all early civilizations. Crude wheels are still used today by many of the primitive peoples of the world.

Modern industry uses an adaptation of the potter's wheel in its jiggering machines. In our complex civilization, where rapid, economical mass-production is of vital importance, the machines of the modern pottery turn out plates and bowls at a remarkable high rate of speed. The basic principles of manufacture, however, are still much the same today as they were centuries ago.

The ultimate goal of nearly every person interested in pottery is to be able to "throw" a piece on the potter's wheel. Even with all the highly specialized machines that are used in modern potteries, many hand-thrown pieces are still manufactured. Where unique beauty and originality are sought, there is no substitute for hand-thrown work. To become expert on the wheel requires years of experience, but an individual can get much enjoyment and satisfaction from throwing if he is willing to spend a few months practicing.

In the United States electric-powered wheels are very popular, though many ceramic craftsmen still prefer the old "kick-type" wheel. The kick wheel requires muscular coordination and concentration on the kicking in addition to the coordination and concentration required for hand operations. The speed of an electric wheel may be controlled either by a permanent setting or by a variable-speed foot pedal.

PROCESS: ALL
MATERIAL: ALL

ACTIVITY
"Related Careers"

Allow 2 class periods

OBJECTIVE: At the conclusion of this activity the student will have developed a knowledge of the occupational opportunities dealing with materials and processes of industry as evidenced by completion of a research paper.

EQUIPMENT AND SUPPLIES NEEDED:

REFERENCE MATERIAL: INDUSTRIAL PLASTICS, pages 265-269, by Baird, Goodheart-Willcox Co. not included
WOODWORKING FOR INDUSTRY, pages 21-26, by Feirer, Charles A. Bennett, Co. included
ACTIVITIES IN CERAMICS, pages 66-77, Thompson, McKnight & McKnight Pub. Co. included

PROCEDURE FOR THE ACTIVITY

1. Teacher Information

   A. The purpose of this activity is to make the student more aware of the many careers that are related to the processing of materials by industry.

   B. Review the reference material.

2. Teacher Presentation

   A. Introduce the students to this activity by explaining that this research paper should be written on a occupation in which they may be interested. The students should complete their research by using the listed books and any other available books. The teacher should establish a deadline for completion of the paper. Students may also write to various companies for literature and information on various careers. Students may also want to check with the counselor.

3. Student Activity

   A. Complete the research paper as described in No. 2A.

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WOODWORKING FOR INDUSTRY by John L. Feirer, pages 21-26

Some People Who Work with Woods--

Each area of woodwork offers many different careers and jobs, from semiskilled work in the furniture industry to professional occupations.

PROFESSIONAL OCCUPATIONS

Architect. Duties: Confers with clients about cost and style; makes preliminary plans and working drawings (including engineering drawings); prepares specifications; prepares list of building contractors; inspects and supervises projects as they are built.

Number: About 24,000 registered and about 5,000 more who are without license.
Education and Training: A license usually requires a minimum of a college or a university degree in architecture plus three years of practical experience in an architect's office.
Future: A great future because of the building boom.

Industrial Education Teacher. Duties: Teaches junior or senior high school woodshop or general shop classes. Teaches carpentry, patternmaking, cabinetmaking or boatbuilding in a vocational or technical school. Must be able to organize instructional materials, teach, and maintain the shop. Works in all kinds of schools including junior high, senior high, vocational or technical, in cities and towns of every size.
Number: About 50 per cent of the 50,000 industrial education teachers teach woodworking full or part time.
Education and Training: A four-year college degree with a specialization in technical and specialization in technical and professional courses in industrial education.
Future: Tremendous demand for industrial education teachers because about 50 per cent of the graduates enter industry each year.

Furniture Designer. Duties: Develops, designs, and creates models of possible new furniture pieces; makes finished drawings and diagrams.
Number: Small numbers are employed by independent designing firms and furniture factories.

Education and Training: Formal training in art, design, and construction in trade or technical schools, or colleges.
Future: There is a limited outlook because of the small number employed.

Interior Designer. Duties: Plans and supervises the furnishing of private homes, offices, and other structures. Selects type of decor, schemes and furnishings; arranges the furniture, draperies, wall and floor coverings, lighting fixtures, lamps, and decorative accessories. Designs and has built special pieces of furniture.
Number: Total is somewhat over 10,000.
Education and Training: Best preparation is a three-year course in art or four-year degree from a college with a major in interior decorating.
Future: The outlook is excellent because of the many homes and offices built each year.

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Forester. Duties: Protects, manages, and evaluates valuable forest land. Safeguards forests from fires, destructive insects, and diseases. Promotes and facilitates forestation; estimates the amount of lumber on forested land, and appraises the value of such land.
Number: about 17,000.
Education and Training: Four years of college leading to a bachelor's degree.
Future: Excellent

SKILLED TRADES AND TECHNICAL OCCUPATIONS

Carpenters. Duties: Rough carpenters make the framework including subflooring, sheathing, partitions, floor joists, studding, and rafters. Finish carpenters install wood paneling, cabinets, built-ins, window sashes, door frames, and hardware. Carpenters work in the construction industry, and in alteration and modernization. They also do maintenance work in factories, hotels, and other large buildings. Some carpenters also do roofing, glazing, and painting.
Number: 1,200,000
Education and Training: Training in a vocational or technical school or a four-year apprenticeship program for carpenters.
Future: Excellent.

Cabinetmakers. Duties: Uses both hand and machine tools; cuts and shapes parts; assembles parts into furniture pieces.
Number. Small number, not exceeding 10,000. A few work in each furniture factory, some in plants that make custom furniture, a few in retail shops that repair and make new pieces, and in department stores as furniture repairmen.
Education and Training: Vocational or technical school program or a three- or four-year apprenticeship.
Future: Limited number of opportunities because of mass production in the furniture industry.

Patternmaker. Duties: Studies blueprints and plans the pattern. Considers the way the object will be cast and the kind of metal used. Selects the proper wood,makes the layout, designs the parts, and fabricates them with hand and power tools.
Number: There are about 7,5000 wood patternmakers--roughly as many as all other kinds of patternmakers combined.
Education and Training: Good trade school and/or five-year apprenticeship.
Future: Slow increase in the number needed.

Painters and Finishers. Duties: Erects scaffolds; mixes paints and finished; handles brushes and other painting tools; uses spray guns and rollers; must know the characteristics of common types of paints and finishes. Applies finishes.
Number: About 400,000
Education and Training: A good trade or technical school or four-year formal apprenticeship.
Future: Excellent.

Business Occupations. There are about 4,000 lumber wholesalers who employ approximately 50,000 people Some 30,000 retail lumber dealers employ about 250,000 people. About 60 percent of all the retail lumber dealers are located in towns of 5,000 population or less.

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VALUES OF WOOD AS A BUILDING MATERIAL:

A renewable abundance of supply. We can and are growing more timber, while we merely are using up our coal, iron ore, and petroleum.

A wide variety of types. Many species of softwoods are available for structural and framing lumber, plywood sheathing, roofing, and subflooring, hardwood for flooring, paneling, cabinetwork and furniture, sports equipment, and musical instruments.

A durable material. Wood has been tested and proved by centuries of hard, practical use. Examples: Beams discovered in an ancient Oriental tomb were found to be perfectly sound after 2,700 years; many homes of wood which were built more than 200 years ago are as sound today as when they were new. Wood has been found to be the best material for tanks for storing many kinds of chemicals.

A strong material. Weight for weight, wood is stronger than any other material.

An attractive material. The beauty, warmth, and richness of wood for furniture, panels, floors, and interiors cannot be equalled by any comparable material.

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ACTIVITIES IN CERAMICS by Seeley Thompson

The Present-Day Pottery Industry

Today American Vitrified China is made in several weights and many shapes and is decorated with designs by the foremost artists of America. Prices of plates range from $6.00 to $5,000.00 per dozen, and American Vitrified China graces the tables of many homes. Because of its durability and beauty, it is used in hotels, restaurants, and other institutions throughout the United States.

More than forty skilled trades are represented by the men and women employed in chinaware manufacturing. Technicians, chemists,masons, carpenters, coopers, engineers, and artists--all have their part in the making of a piece of china. Wages constitute over sixty per cent of cost (factory selling price). China making is one of the few ancient crafts which exist today as great industries, requiring the handwork of artisans and the talent of highly trained craftsmen.

The Bureau of Census for 1950 ranks clay as the thirteenth most valuable raw material in the United States. The principal clay-producing states in order of quantity are Ohio, Pennsylvania, Georgia, and Illinois. In order of value they are Georgia, Ohio, Pennsylvania, and South Carolina. There were 9,707 establishments with 485,337 employees listed in the industrial grouping of Stone, Clay, and Glass Products. The 1951 profit-before-taxes of this industrial group was $991,000,000.

Manufacturing Processes

Many different parts of the United States and Europe contribute the materials for making china. There are four principal ingredients:

First, china clay or kaolin. Kaolin is now used to designate all pure clays which are white when burned.

Second, a very plastic clay called "ball clay", added to facilitate the shaping of the ware.

Third, feldspar, the mineral (silicate of aluminum) from which clay is the chief substance formed when the mineral is decomposed by the weather. Feldspar combines with other substances and fuses together in the firing process.

Fourth, quartz, one of the most common of all rock-forming minerals, used to hold up the body structure of the china and to give it strength.

Most china makers jealously guard their manufacturing formula. However, a typical formula would include a little over one-third of potter's flint or pulverized quartz, a little under one-third kaolin or china clay, about one-fifth feldspar, one-tenth ball clay, and small quantities of talc, marble, and whiting. The materials of water, by weight, is added. The mixture is stirred and beaten by arms inside the plunger. When it reaches a milk-like condition, it is drawn off over magnets to remove all iron particles, which would strain the ware. The liquid mixture, called "slip", is then passed through fine sieves (some as fine as 200 mesh to the inch) to further remove lumps and other impurities. It is then stored in a tank.

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From the storage tank, the slip is pumped to a filter press. The filter press is a large machine containing a number of canvas bags or filter cloths. Under considerable pressure, surplus water is squeezed out of the slip, leaving behind on the cloth a thin square slab of plastic clay. These square slabs of clay are removed from the bags prior to a final conditioning operation.

The clay from the filter press is solid but not sufficiently plastic for the potter. Air bubbles must be driven out of the clay and it must be thoroughly kneaded. Both of these operations are performed by the pug mill. This machine is similar to a huge sausage machine or meat grinder. Square cakes of clay are fed into the machine, and an homogeneous, endless, snake-like roll of clay is squeezed out. This is cut into suitable lengths for the ware makers.

The first step in the production of a piece of pottery is to design the shape. The designer must know the limitations and characteristics of clay. He must be familiar with all the various processes of the industry. This man works closely with the other experts who will be responsible for the production of his designs. From the designer, drawings are taken to the modeller.

The modeller makes a clay model of every design. The model must be scaled in "clay size," that is, larger than the finished piece. Plaster of Paris molds will be made from the original model. Reproductions from these molds shrink as they dry from "wet clay" to "dry clay," and again during the firing process. These contractions must be calculated and allowance made for them by the modeller.

The clay model is then sent to the mold maker. The molds are made from Plaster of Paris, because this material absorbs water quite rapidly, and the molds can be used again and again. Great care is taken to insure a perfect fit for all parts of the mold. Notches or pins (joggles) in one side of a mold fit corresponding recesses in the opposite side of the mold, thus insuring a close and accurate fit. The mold is actually made about one-seventh larger than the finished china piece. Molds for articles such as cups or plates are made by the mold maker to fit the head of the potter's machine or wheel.

The finished plaster of Paris molds are sent to the "caster." Liquid clay (slip) is poured into the sealed molds. The molds absorb the water from the slip, and the clay adheres or is deposited on the inside walls of the molds. The thickness of the clay coating depends on the length of time the slip is left in the molds. The caster must carefully judge when to pour out the surplus slip to attain correct thickness. The molds are then set aside to dry.

In drying, the cast piece contracts and can be removed when the mold is opened. The cast article is then carefully cleaned and the seams which appear at the "parting line" of the mold are smoothed away. Spouts are also cast in much the same fashion. All clayware in the unfired state is called "greenware" and is very fragile. Great care must be used when handling greenware to avoid straining or breaking it. Even if a piece is not broken, a strain might result in a defect after firing.

Plates are made on a machine called a "jigger." A jiggerman, a helper who "bats out" and runs the molds, and a finisher make up each working crew. The "batter out" takes a lump of clay from the pug mill, forms it into a ball, and places it upon a revolving spreader. A beveled-edge tool is lowered which flattens the clay into a disc of just the

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right thickness. The batter out then picks up the flattened clay disc and with considerable force slaps the disc onto a plate mold. This procedure requires skill, since the disc of clay must not be stretched. The jiggerman then places the clay-covered plate mold on a whirling jiggerhead, dips his right hand into water and presses the bat firmly while with the other hand he pulls down a profile tool to shape the back of the plate. The face of the plate takes the contour of the top of the mold. Surplus clay is trimmed from the edge and the jiggered piece and mold are placed on the drying rack. After the ware is dry enough to handle and has shrunk from the mold, it is removed and stacked on boards. The finisher then takes a stack or "bung" of pieces and places them on a whirler. With a tool ground to the proper curve, the finisher cuts off the rough edge and smoothes up each piece with a wet sponge.

Operations for making cups and bowls and similar symmetrical hollow ware are somewhat different. Pieces of this sort are made on the inside of a mold, whereas flatware is made on the outside of the mold. Cups are made on a machine called a "jolley." An assistant, using a device made of many cutting wires, slices a pug of clay into many equal parts, each one just large enough to form a ball of clay in his hands. The ball of clay is pressed into the mold. The mold is then placed on the rotating head of the jolley and the cup maker skillfully draws up the clay, inside the mold. He then pulls down a lever to which is attached a profile, correctly shaped to form the inside of the cup. The "setting" of the profile regulates the thickness of the cup. The molds, with the cups inside, are then placed in dryers and are finally smoothed up by a "cup sponger."

Cast handles are made in two-piece molds, usually one dozen to a mold. The handles are arranged like the limbs of a tree, the trunk representing the channel through which the slip is poured to reach each branch. When the excess water has been absorbed, the tree is removed, the handles separated from the trunk, and the outside edge and center of each handle trimmed with a knife and finally smoothed with a sponge. The handles must be kept at the same moisture content as the cups or vessels to which they will be applied, if they are to adhere well.

The "cup handler" dips the ends of the moist handles into slip and sticks them squarely and in uniform position onto the cups. So great is the adhesion that a cup can be suspended by the handle immediately after placing. Excess slip is sponged off and the cups are removed to the "greenroom." Sometimes solid clay handles are made by pressing clay into a mold or from clay squeezed into long strips through a "dod machine" (a die) and then cut and shaped by hand.

Throwing is one of the most ancient methods of making pottery. It remains today as it was in biblical times, although the potter's wheel is usually powered with an electric motor. The "thrower" can control, the speed with a foot pedal while he shapes the pieces with his hands. Throwing is a true handcraft, requiring a fine sense of touch and superb dexterity. An infinite variety of shapes can be created on the wheel, but this process is more costly than casting or jolleying, since it calls for exceptional skill.

When the clay piece from the thrower or jolleyer has dried to a consistency known as cheese-hard or leather-hard, it is ready for the "turner", who works at a lathe similar to the type used for turning wood or metal. The turner shaves off surplus clay to the correct outline and dimension. Beads or fillets can be made on the ware at this time by impressing a special tool called a "runner" against the revolving damp ware. To finish the piece, the turner reverses the direction of the lathe and burnishes the surface with a smooth steel tool.

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Embossed or hand-applied clay bas-reliefs (rasied work) are sometimes applied to ware for ornamentation. The ornaments are made by pressing clay into flat molds. The clay ornaments are removed from the molds, the surface of the clayware moistened with water, and the ornament fixed to the ware by the skillful pressure of the craftsman's fingers. A sensitive touch is necessary, since the fine details of the ornaments are easily spoiled.

When clayware is "white hard"--that is, when it has dried in air to a chalk white--it is ready for firing. The first oven or kiln firing of the ware is called "bisque." Some potteries use a continous electric oven. The ware is placed on tiers of refractory fire clay shelves, which are built on oven trucks. Articles such as plates are "bedded" in layers of sand, a firm but mobile support which allows the ware to contract evenly. Trains composed of many trucks are propelled slowly in opposite directions through the tunnel ovens. The maximum temperature in the firing zone is usually 1200 degrees Centigrade for the bisque fire and 1160 degrees Centigrade for the second firing to glaze the ware. During bisque firing, clay is transformed into a hard, durable but porous substance known from its texture as "biscuit ware."

In many potteries the use of saggers is still quite common. Saggers are fire clay boxes of various sizes into which the ware is fitted and bedded. The saggers are then loaded into the kiln for firing. In both the bisque and glost or glaze firings, the saggers keep the direct action of the fire from the ware. Along the sides of the kiln are peepholes through which the kiln fireman can see pyrometric cones. The cones resemble small, three-sided pyramids and are made from special clay formula which melt, or bend, at a specific temperature. Cones of various critical temperatures show the fireman the heat action of the kiln. The most popular kiln today is the tunnel kiln, fired by gas, oil, or electricity.

Older "beehive" type kilns used wood and coal. Tunnel kilns may be either circular or straight line. Capacities vary in accordance with size, but in the firing process they are essentially the same. The progress of the ware is continous as it moves from the cooler part of the kiln to that of greatest heat, where absolute vitrification takes place. From the center of the kiln the ware travels along through a gradually cooling temperature until, at the end of about sixty hours, the firing is complete and the ware reaches the exit door.

Ware which went into the kiln as clay has been transformed into china–hard, dense, strong, and highly translucent, but with its surface still dull and rough. The ware is now wedged tightly into a machine called a tumbler. This is a large wooden box in which there are pebbles or pieces of broken bisque. As the tumbler rotates, the ware is cleaned and polished, producing the smooth surface necessary for the application of underglaze decoration.

Color decoration is a very old art. The large variety of types of decoration represent the accumulative work of artists throughout the history of the world up to the present time. Hand painting, hand-fill, print and decalcomania transfer, band and line, and airbrush treatments are some common techniques. All gold work is applied over the glaze and therefore cannot be used on bisque china prior to glazing. Overglaze decoration can be distinguished from underglaze decoration is smooth because the glaze covers the design.

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Ceramic colors must be of mineral base; otherwise, they would be destroyed in the intense heat of the kiln. They do not represent as wide a range of colors as those for other arts, nor are they as flexible. For example, a combination of china colors used in the same design must not be chemically opposed to each other, and they must fuse or develop at the same heat. Many colors are affected by the glaze composition, and therefore it is necessary for each pottery to create a color palette suitable for its own requirements. Powdered colors are ground and processed before they are used in the decorating department or, as in some potteries, in the printing department, where large decalcomania sheets are produced.

In the printing department, a pattern which is designed for reproduction by printing is first drawn to fit the curves of the various pieces of ware to which it will be applied. It is engraved on a flat copper plate or on a copper cylinder. This is done with a sharp-pointed tool called a "graver." Light and shade effects are obtained by minutely graduated punched dots. This work calls for an extremely high degree of skill, acquired only after many years of experience. As many as sixteen colors--all in perfect register and each requiring a separately engraved plate or cylinder--are sometimes necessary to reproduce a pattern.

Heat-softened color is rubbed into the engraved lines and a print taken on specially prepared tissue paper by pressing the copper plate or cylinder with the tissue paper. The engraved copper cylinder prints the pattern on a continous roll of paper. The color is fed to the cylinder, which is heated by an electric element in its center.

The "transferrer" cuts away all superfluous tissue paper and applies the print paper. It is vigorously rubbed onto the ware, first with a flannel cloth and then with a hard brush to insure that it adheres firmly and evenly. Afterwards the paper is washed off, leaving the pattern or design transferred to the ware. The ware is often passed through an electric kiln (enamel kiln) at a low temperature to fuse the color prior to glazing.

Many patterns are made more beautiful by the addition of a line or band to accent the modeling of the shape or to give contrast in color. While some lining has recently been done by mechanical means, lining is still done by hand in most potteries. On a revolving wheel, which the "liner" turns by hand, he quickly and accurately centers the piece of ware. Gauging the placement with his eye, he touches the china with a brushful of moist color and, as it spins, a line encircles its edge. The clean, forceful strokes on handles, spouts, and fluted rims are all done by hand. The exactness of the width of line is only a small portion of the skill required of this art.

Hand painting, one of the oldest methods of decorating, is still being done commercially to create pieces of china of outstanding beauty. This is an art in itself and one in which the artist must have long experience.

Hand-fill is done by placing colors within outlines already made by the print process. This freehand manner of applying many colors produces very artistic effects. Decorating with airbrush and other new methods being devised tend to give greater variety to decorated china.

Decorated ware and bisque ware are now ready for the glaze dipping process.

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Glaze is prepared in one part of the plant and piped in liquid state to a large vat, where it is allowed to settle. Water that rises to the surface is drawn off, and the balance of the glaze mixture is thoroughly stirred. Then the mixture is poured into dipping tubs. The ware is then dipped into the liquid glaze and put aside to dry.

After dipping, each piece of ware is placed on a truck to be fired again. The process is very similar to that of "biscuit" firing, which has already been described. In the glost oven, however, the pieces must not be allowed to touch one another or they would be fused together by the glaze, which is vitrified at a high temperature. Various articles are kept apart by specially manufactured fire-clay supports (stilts and saddles). These fine-pointed supports upon which flatware is placed for glost firing leave small marks on the ware. These are removed by chiselling with a wedge-shaped steel tool, and the "polisher" removes any minute blemish or roughness which might remain by carefully grinding with a carborundum wheel and then by polishing with a wooden or flannel wheel.

Ware which later will be decorated over the glaze (overglaze decoration) and china already decorated are selected according to standards established in each plant. Overglaze decorations may be applied and the ware fired in the enamel kiln. For any decorated ware on which a gold line or other gold treatment is to be placed, the finest coin gold is used. This is a chocolate brown paste, transformed by firing and burnishing into gleaming gold.

The final work has now been done and the ware is ready to be packed into barrels with straw or into neat cartons for shipment.

In the last quarter of a century in this country greater strides have been made in the creative development of pottery than in the previous two hundred years. American china is the prized possession of many of our homes, and in it is expressed much of the art and culture of the American people.

PROCESS: ALL PROCESSES
MATERIAL: ALL

ACTIVITY
"Ecology: Materials and Processes"

Allow 1 class period

OBJECTIVE: At the conclusion of this activity the student will have a knowledge of the ecological problems created by materials and processes as evidenced by completion of a short research paper. (Paper written outside class)

EQUIPMENT AND SUPPLIES NEEDED:

REFERENCE MATERIAL: Provided information sheet.

PROCEDURE FOR THE ACTIVITY

1. Teacher Information

   A. Introduce the students to this unit by pointing out some examples of what industry is now doing about recycling of materials. An example is the recycling of Coors aluminum beer cans.

2. Student Activity

   A. Have the students select an ecological problem or question from those discussed. Students may wish to select some problem related to local pollution.

   B. Students should write a research paper according to the following outline:

      A. Describe the problem
      B. How long has this problem existed, and what is responsible for the problem?
      C. What measures are being taken to solve the problem?
      D. How much are the corrective measures expected to cost? Who will pay for them?
      E. Is there a group in your community actively engaged in solving this problem? How can you and your school help.

   C. As a part of the report, the students may collect newspaper articles and booklets related to the problem.

   D. It may also be possible to have each student give a short 2 to 3 minutes report about their research.

VII. STUDENT CONTRACT WORK

The purpose of the independent study activity is to allow the students to work in an area of their own interest. An example of the contract form may be found in Appendix G.

The procedures that should be followed for this activity are:

1. Explain the purpose of the contract, and have students make plans for their contract proposal.
2. The working time allowed for the contract should be adjusted to fit the time availability for each school.
3. Two copies of the contract should be completed by each student. The student should have one copy with him in class each day in order to keep records of the completed daily work and the teacher should keep the other copy.
4. If the student is going to build a project, a set of plans and a list of material and its cost should be provided on the contract. This should be kept by the teacher.
5. The scope of the contract should be related to the materials and processes field. The teacher should check *carefully* to see that the student does not begin a task that will extend over the final day of the contract date. The teacher should also check project difficulty, and the equipment and supplies that will be needed.
6. The teacher should help each student individually during their contract work.
7. At the completion of the contract work the student should present the project, daily log, etc., to the instructor for evaluation.

SECTION VIII. CONCLUSION

Provide all students with an answer sheet form and a copy of the Post-Tests* for Materials/Processes. Have students fill out all required information on the answer sheet form.

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*attitude inventory and cognitive test

APPENDIX A

DEFINITION OF BEHAVIORAL OBJECTIVES

*The three levels of behavioral objectives are: cognitive, affective, and psychomotor. To describe the variable of cognitive and affective behavior, definitions from Bloom and Kratwohl are utilized. The definitions for psychomotor behavior are those described by Dave.

Cognitive Variables: Behaviors which place primary emphasis on the mental or intellectual process of the learner:
The levels are:

Knowledge- Involves the recognition and recall of facts (i.e., defining terms, recalling names, dates, persons, indentifying words, etc.)

Comprehension- The learner interprets, translates, summarizes, or paraphrases given material into another language or form of communication (i.e., reading a book or musical scores, grasping the thought of material studied, ability to describe something in one's own words, etc.)

Application- Involves the use of material in a situation which is different from that situation in which it was originally learned (i.e., the use of abstract ideas, principles, or theories in problem-solving).

Analysis- Involves separating a complex entity into its parts, drawing comparisons and relationships between the elements (i.e., ability to recognize assumptions, to distinguish cause and effect relationships, reorganization of biases or points of view, etc.)

Synthesis- Involves combining elements to form a new original entity. It involves a process of working with pieces, parts, elements, etc., and arranging them in a structure that was not clearly evidenced before (i.e. ability to produce a play, music, art forms, design products, or formulate solutions).

Evaluation- Involves acts of decision-making, judging, or selecting based on a given

Synthesis cont.

set of criteria. These criteria may be objective or subjective (i.e. ability to indicate fallacies, compare a work or an idea with known standards, etc.)

Affective variables: Behavior which primarily emphasizes attitudes, emotions, and values of the learner and are usually reflected by interests, appreciations, and adjustments. The levels are:

Receive-	The learner is aware of, or passively attending to certain phenomena and stimuli (i.e., listening, being attentive to, etc.)
Respond--	The learner complies to given expectations by attending or reacting to certain stimuli or phenomena (i.e., obeys or participates as expected, etc.)
Value-	The learner displays behavior consistent with a single belief or attitude in situations where he is not forced to comply or obey (i.e., demonstrates a definite preference, displays a high degree of certainty and conviction, etc.)
Organization*	The learner is committed to a set of values as he displays or communicates his beliefs or values (i.e. develops a rationale for a set of values, makes judgments about sets of values).
Characterization*-	The total behavior of the learner is consistent with the values he has internalized (i.e., develops a consistent philosophy of life, exhibits respect for the worth and dignity of human beings, etc.).

* Levels four and five are seldom used in performance objectives at the instructional level. Therefore, the educator may find these levels inappropriate for us in writing performance objectives to be achieved over short time periods.

Definitions cont.

Psychomotor Variables: Behaviors which place primary emphasis on neuro-muscular or physical skills involving various degrees of physical dexterity. The levels are:

1. Imitation- When the learner is exposed to an observable action, he begins to make covert imitation of that action. Such covert behavior appears to be the starting point in the growth of psychomotor skill. This is then followed by overt performance of an act and capacity to repeat it. This performance, however, lacks neuromuscular coordination or control, and hence is generally in a crude and imperfect form (i.e., impulse, over repetition).

2. Manipulation- Emphasizes the development of skill in following directions, performing of selected actions, and fixation of performance through necessary practice. At this level, the learner is capable of performing an act according to instruction rather than just on the basis of observation as in the case at the level of imitation (i.e., following directions).

3. Precision- The proficiency of performance reaches a higher level of refinement in reproducing a given act. The learner performs the skill independent of a model or a set of directions. Here, accuracy, proportion, and exactness in performance become significant (i.e., reproduction, control, errors reduced to a minimum).

4. Articulation-Emphasizes the coordination of a series of acts by establishing appropriate sequence and accomplishing harmony or internal consistency among different acts (i.e., performance involves accuracy and control plus elements of speed and time).

5. Naturalization- A high level of proficiency in the skill of performance of a single act is required. The behavior is performed with the least expenditure of psychic energy. The act is routinized to such an extent that it results in automatic and spontaneous response (i.e., performance becomes natural and smooth).

* Developing and Writing Performance Objectives, Booklet #2, Educational Innovators Press, P.O. Box 13052, Tucson, Arizona, 1971.

APPENDIX B

DEFINITION OF TERMS

DEFINITION OF TERMS

MATERIAL ANALYSIS AND PROCESSING SYSTEMS--is the study of organic and inorganic materials and how they are changed to satisfy man's material needs.

MATERIAL DEFINITION:

ORGANIC MATERIAL--those materials pertaining to or derived from living organisms. Example of organic material: wood, leather, paper, textiles, plastics, rubber, petroleum, natural gas, etc.

INORGANIC MATERIAL--those materials that are matter other than animal or vegetable. Examples of inorganic materials: ceramics, clay, glass, enamel, concrete, stone,.etc.

PROCESS DEFINITION:

COMBINING PROCESS--is any number of methods that involves the joining of material together permanently or semi-permanently and the treating of the surface of a material for the primary purpose of appearance and/or protection.

SEPARATING PROCESS--is any number of processes that involves the cutting or removing of pieces of material from a base material by using a wide range of hand and machine tools and also by the use of heat and various chemicals.

FORMING AND/OR CONDITIONING PROCESS--is any number of processes that involve imparting a specific shape or cross section to a material without adding or removing any of the material. This process is used for the purpose of achieving a desired configuration and also results in a stronger product.

CHANGED MATERIALS DEFINITION:

STANDARD STOCK--material or stock that requires further processes before being useful to the consumer.

STANDARD PART OR COMPONENT--a part or component requiring no further processes except assembly.

SUB-ASSEMBLY--standard part or components combined to produce sections of a finished product.

FINISHED PRODUCT--a completed consumer product

ASSEMBLY--combination of sub-assemblies and/or components

BY-PRODUCT--the recycling of rejected or reuseable standard parts components.

APPENDIX C

S.E.T. PROJECT
MATERIAL ANAYLSIS AND PROCESSING SYSTEMS CURRICULUM

ATTITUDE INVENTORY TEST

ATTITUDE INVENTORY ANSWER SHEET

ATTITUDE INVENTORY TEST EVALUATION PROCEDURE AND KEY

MATERIAL ANALYSIS AND PROCESSING SYSTEMS

ATTITUDE INVENTORY

DO NOT WRITE ON THIS TEST FORM. USE YOUR ANSWER SHEET!

1. I am afraid to operate machines used in the material analysis and processing systems course.
2. I want to be a cabinetmaker.
3. Physical education is more fun than the material analysis and processing systems class.
4. I would never want to be a welder.
5. The Material Analysis and Processing Systems course will help me in my future career choice.
6. I dislike classes that involve all book work.
7. Safety need not be emphasized in material analysis and processing systems.
8. Material analysis and processing systems of industry makes up the largest part of our modern economic system.
9. This material analysis and processing systems class is an important part of the school curriculum.
10. Material analysis and processing systems class should consist on only building projects.
11. I feel comfortable in the material analysis and processing systems class.
12. The study of ecology does not belong in the study of material analysis and processing systems.
13. This course should give me a good idea how industry utilizes material analysis and processing systems.
14. The material analysis and processing systems class should emphasize the skill of using hand tools.
15. Material analysis and processing systems class will help me think about my future.
16. The study of properties and characteristics of wood does not belong in the study of material analysis and processing systems.
17. I would rather work as a group member than individually in material analysis and processing systems.

ATTITUDE INVENTORY continued

18. I feel plastics is one of todays major industrial materials.

19. Material analysis and processing systems class is more fun than study of power and energy.

20. I understand and appreciate the value of wood lamination in the construction industry.

w1. I enjoy working with wood better than any type of material.

22. No matter what the work is, it should be done well.

23. Every person should be proud of his work.

24. Clean work is most desirable.

MATERIAL ANALYSIS AND PROCESSING SYSTEMS

ATTITUDE INVENTORY

Student's Name

Read the statements carefully and circle the "yes" response if you agree; circle the "no" response if you disagree; circle the "undecided" (und) if you do not know for sure. There is no right or wrong answer. The results will not effect your grade and will be held in confidence. Please answer honestly!

1.	no	und	yes
2.	no	und	yes
3.	no	und	yes
4.	no	und	yes
5.	no	und	yes
6.	no	und	yes
7.	no	und	yes
8.	no	und	yes
9.	no	und	yes
10.	no	und	yes
11.	no	und	yes
12.	no	und	yes
13.	no	und	yes
14.	no	und	yes
15.	no	und	yes
16.	no	und	yes
17.	no	und	yes
18.	no	und	yes
19.	no	und	yes
20.	no	und	yes
21.	no	und	yes
22.	no	und	yes
23.	no	und	yes
24.	no	und	yes
25.	no	und	yes

ATTITUDE INVENTORY

EVALUATION INFORMATION

The results of the attitude inventory will determine the affective learning of students in the Material Analysis and Processing Systems class.

These following questions should be answered with a positive "yes" response.
5, 8, 9, 11, 13, 16, 18, 21, 23, 25, 26, 27, 28

These following questions should be answered with a positive "no" response.
1, 7, 8, 12, 17, 19, 20

APPENDIX D

S.E.T. PROJECT
MATERIAL ANALYSIS AND PROCESSING SYSTEMS

PRE–POST TEST

ANSWER SHEET AND KEY

MATERIAL ANALYSIS AND PROCESSING SYSTEMS TEST

PLACE ALL ANSWERS ON ANSWER SHEET!

1. An arc welder is best suited for:

   A. forming
   B. combining
   C. separating
   D. conditioning

2. Which of the following products should be conditioned?

   A. screwdriver
   B. bread board
   C. candle holder
   D. tool box

3. Steel is:

   A. a natural material
   B. an organic material
   C. an alloy
   D. an element

4. A process of heating steel and then hammering it to some shape is known as:

   A. casting
   B. milling
   C. forging
   D. separating

5. A metal that contains little or no iron is known as:

   A. ferrous
   B. non-ferrous
   C. an alloy
   D. a compound

6. Which of the following processes can not easily be performed on cast iron?

   A. filing
   B. cutting
   C. bending
   D. drilling

7. Steel is not:

A. magnetic
B. corrosion resistant
C. a ferrous material
D. an alloy

8. Recycling of metal products is done to:

A. reduce labor costs
B. produce higher quality materials
C. conserve natural resources
D. all of these

9. Name a use for the by-products of the steelmaking process:

A. plywood construction
B. substance in asphalt road covering
C. paper laminating
D. gasoline distillation and condensation

10. Which of the following processes does involve material loss?

A. punching a hole in sheet metal
B. drilling a hole in sheet metal
C. cutting sheet metal with a tinsnips
D. bending sheet metal with the barfolder

11. The hardness of steel depends on:

A. primary alloy
B. aluminum
C. its shape
D. the carbon content

12. The existance of carbon in steel determines its ability to:

A. be heat treated
B. conduct electricity
C. radiate heat
D. be magnetized

13. The chemical element considered to be the backbone of plastic is:

A. Oil
B. Wood
C. Carbon
D. Water

14. Upon heating, _______ material will soften and then harden when they are cooled.

    A. Thermoplastic
    B. Thermosetting
    C. Synthetic
    D. Wood

15. _______ material form a cross-link between adjacent molecules, usually during molding, that will prevent the plastic flow with the addition of heat.

    A. Thermoplastic
    B. Thermosetting
    C. Synthetic
    D. Wood

16. _______ is a process of forming where a plasticized thermoplastic material is injected or forced under pressure into a closed mold where it cools to form a product.

    A. Extrusion Molding
    B. Injection Molding
    C. Compression Molding
    D. Foam Molding

17. A process of molding in which thermoplastic materials are shaped by forcing them through a die orifice to produce a continous shaped rod, wire, cable, etc. is

    A. Extrusion Molding
    B. Injection Molding
    C. Transfer Molding
    D. Rotational Molding

18. Blow molding was originally developed to produce

    A. glass containers
    B. expoxy resin
    C. polystryene beads
    D. solvent cement

19. Drilling, boring and reaming are separating processes that can be performed on the _______, given proper attachments.

    A. radial arm saw
    B. metal lathe
    C. drill press
    D. all of above

20. ____________is a process of forming a hollow seamless object by the use of liquid or powder placed in a hollow mold and moved on two axes.

A. Foam Molding
B. Injection Molding
C. Transfer Molding
D. Rotational Molding

21. Products such as 4′ x 8′ sheets of glass or 10 ′ lengths of galvanized pipe are classified as:

A. components
B. standard stock
C. subassemblies
D. by-products

22. ______is a process of forming a thermoplastic material by heat or pressure.

A. Thermoforming
B. Casting
C. Coating
D. Lamination

23. Waste material from injection molding can be reused because it is a______material.

A. thermoplastic
B. thermosetting
C. coating
D. casting

24. A milling machine is used to perform ________operations on metals.

A. separating
B. combining
C. forming
D. conditioning

25. ______ refers to any of a number of processes in which a liquified material is poured into a suitable mold and solidifies to form the product.

A. thermoforming
B. heating
C. curing
D. casting

26. The chemical that triggers the resin and causes it to set up hard is called:

    A. acetals
    B. catalyst
    C. solvent
    D. urea

27. Prolonged heating of a plastic such as the acrylics at temperatures lower than those used for forming followed by slow cooling is called:

    A. annealing
    B. curing
    C. welding
    D. stamping

28. Screening, floating and filtering are examples of:

    A. separating
    B. combining
    C. forming
    D. conditioning

29. Dip molding processes makes use of which one of the following types of molds:

    A. an internal mold
    B. a hollow mold
    C. an external mold
    D. all of the above

30. Slush molding makes use of a ______________ filled with plastisol.

    A. an internal mold
    B. an external mold
    C. hollow heated mold
    D. none of the above

31. Post-processing activities include:

    A. conditioning and finishing
    B. coating and polishing
    C. assembly and packaging
    D. installing and maintaining

32. Most high pressure lamination is done on the:

    A. rotational molder
    B. extrusion molder
    C. injection molder
    D. compression molder

33. A one-piece product may be a________of a larger product, or a

A. component, finished product
B. subassembly, standard stock item
C. part, subassembly
D. by-product, component

34. Two primary molding methods of reinforced molding are:

A. low pressure, open molding
B. high pressure, transfer molding
C. casting, low pressure
D. slush molding, static molding

35. ________and________ are the names of two types of fiberglass materials that can be used for reinforced plastic molding.

A. film, sheet
B. resin, cloth
C. mold release, mat
D. cloth, mat

36. _________is the principal resin involved in the manufacture of expandable beads which contains a gas which will expand when heat is applied.

A. polyurethane
B. polystyrene
C. cellulose acetate
D. epoxy

37. ____________is used for bonding together of thermoplastic material.

A. epoxy cement
B. silicone adhesive
C. solvent cement
D. all of the above

38. The term abrading applies to the separating process of:

A. milling
B. precision grinding
C. etching
D. planing

39. Forging, bending, and drawing are all material forming processes of which type?

A. casting or molding
B. conditioning
C. compressing or stretching
D. chip removing

40. Heating a metal rod and allowing it to cool slowly so that it can be shaped is an example of:

    A. compressing or stretching
    B. conditioning
    C. shearing and fracturing
    D. coating or bonding

41. A finished product such as a radio may be classified as:

    A. a component
    B. a sub-assembly
    C. a part
    D. an assembly

42. None of the material is lost along the parting lines during:

    A. sawing
    B. drilling
    C. sanding
    D. shearing

43. Filing the rough edge from a casting is an example of:

    A. shearing
    B. chip removal
    C. thermal erosion
    D. conditioning

44. Man-made materials are called:

    A. extractive
    B. synthetic
    C. reproducible
    D. none of these

45. Which is not a basic way of forming material?

    A. casting
    B. compressing
    C. stretching
    D. chip removing

46. __________is a process of building up the thickness or width of material by placing several layers of materials together.

    A. casting
    B. lamination
    C. bonding
    D. thermoforming

47. ____________ is a process of coating a wood to improve its appearance by changing its color, bring out the grain, presserve it and sometimes to imitate the more expensive woods.

    A. staining
    B. filling
    C. bonding
    D. polishing

48. ________________________ is a bonding process where two materials are rotated at a high rate of speed against each other and this causes heat which will melt the plastic and fuse it together.

    A. fusion welding
    B. friction welding
    C. gas welding
    D. heat sealing

49. ________________________ is a process where a nichrome wire is heated for only a few seconds to soften the plastic, and then the wire cools under pressure to form a excellent narrow seal.

    A. dielectric sealing
    B. friction welding
    C. fussion welding
    D. impulse sealing

50. To apply by hand successive layers of glass cloth and resin is a process called:

    A. lay-up
    B. parison
    C. orifice
    D. casting

S.E.T. PROJECT MATERIAL ANALYSIS AND PROCESSING SYSTEMS
CURRICULUM ANSWER SHEET

DATE __________ HOUR __________ NAME ______________________________

CLASS ______________ STUDENT # ______________________________

INSTRUCTIONS:

Circle or black out the letter of the correct response; choose only the one best answer. Make no marks on the test. Mark all answers on this sheet.

1. A B C D
2. A B C D
3. A B C D
4. A B C D
5. A B C D
6. A B C D
7. A B C D
8. A B C D
9. A B C D
10. A B C D
11. A B C D
12. A B C D
13. A B C D
14. A B C D
15. A B C D
16. A B C D
17. A B C D
18. A B C D
19. A B C D
20. A B C D
21. A B C D
22. A B C D
23. A B C D
24. A B C D
25. A B C D
26. A B C D
27. A B C D
28. A B C D
29. A B C D
30. A B C D
31. A B C D
32. A B C D
33. A B C D
34. A B C D
35. A B C D
36. A B C D
37. A B C D
38. A B C D
39. A B C D
40. A B C D
41. A B C D
42. A B C D
43. A B C D
44. A B C D
45. A B C D
46. A B C D
47. A B C D
48. A B C D
49. A B C D
50. A B C D

KEY FOR MATERIAL ANALYSIS AND PROCESSING SYSTEMS
PRE–POST TEST

Correct Responses:

1. B 2. A 3. C 4. C 5. B 6. C 7. B 8. C 9. B
10. B 11. D 12. A 13. C 14. A 15. B 16. B 17. A 18. A
19. D 20. D 21. B 22. A 23. A 24. A 25. D 26. B 27. A
28. A 29. A 30. C 31. D 32. D 33. A 34. A 35. D 36. B
37. D 38. B 39. C 40. B 41. D 42. D 43. B 44. B 45. D
46. B 47. A 48. B 49. D 50. A

The instructor should evaluate each pre-test and record the results for comparison with the overall test results to find possible areas of strengths and weaknesses in the class. The post-test results should be compared to the pre-test to see if the performance objective was met.

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APPENDIX E

SUGGESTED EQUIPMENT LIST FOR MATERIAL ANALYSIS AND PROCESSING SYSTEMS

SUGGESTED EQUIPMENT LIST FOR MATERIAL ANALYSIS AND PROCESSING SYSTEMS

PLASTICS

1 Injection Molding Machine, 1/5 ounce or larger Simplomatic PL-63 or equal--Molds included.
1 Compression/Laminating Press, 12 ton: Wabasl, Carver, Emco or 25 Ton Dake. Mold included.
1 Vacuum Forming Machine, Dymo Form 4000 or Model SA-1014 by Orbit
1 High Temperature Oven, Hytherm Co. Model 602 or equal
1 Hot Plate Model HPA 2235M Thermolyne or equal
1 Rotational Molding Machine, Vega Model 14, Emco Model 812-K with supply kit and molds.
1 Two Burner Stove, Sears or equal
1 Impulse Sealer, Audion Model 230-A or equal
1 Plastic Strip Heater, Hytherm Co. Model 16 or equal
1 Kamweld Plastic Welding Kit, Model 15 TM or equal
1 Engraver Outfit, Scott SM300K or equal
1 Buffer, Balder, Rockwell or equal 8"
1 Pressure Cooker, 10 qt. or larger, Sears or equal
1 Triple Beam Investment Scale
1 Heat Gun, Eddy Model EP-5 or equal
1 Fluidized Bed Coater, Emco #1218 or equal
1 Rubber Stamp Press, Simple X Model 58 or equal
2 Slush Molding Kicking Tee Molds
1 Thermos Jug Mold for Expandable Beads
1 Air Compressor, Spray-it Model T6000 or equal

WOOD

Woodworking Hand Tools that can be found in most shops.
1 Belt & Disc Sander, 12" Disc 6" Belt Rockwell or equal
1 Tilting Arbor Circular Saw, 10" Rockwell or equal
1 Scvoll Saw, 14" Rockwell or equal
1 Band Saw, 14" Rockwell, Delta or equal
2 Drill Press, 15" Variable speed, Rockwell or equal Floor Model
2 Wood Lathe, Heavy duty, 12" Variable speed, Rockwell or equal
1 6" Long Bed Jointer, Rockwell Model 37-220 or equal
2 3/8" Power Hand Drills, Rockwell Model 676 or equal
3 Portable Belt Sanders, Model 503 3x24 Dustless Rockwell or equal
1 Portable Sabre Saw, Model 348 or equal
1 Portable Router, Model 91264, Stanley or equal

METAL

1 Metal Working Hand Tools for Most Metal Shops
1 Metal lathe & vertical mills, Edelstahl Maximat Model No. 5003 or equal
1 Drill press, 15" Variable speed, Rockwell or equal

METAL continued

1 Tool Grinder, 6", Rockwell or equal
1 Metal Cutting Band Saw, Kalamazo or equal
1 Hand operated Benders, Di-Acro Model No. 2 or equal
1 Di-Acro, 6" Rollers, Model No. 1
1 Foot Squaring Shears, No. 132, Pexto or equal
1 Box and Pan Brake, Px-24 Pexto or equal
1 Punch Press, 6", Di-Acro Model 1 or equal
1 Notcher, 6" x 6", Di-Acro Model 1 or equal
1 Bar Folder, Niagara Model 3 or equal
1 Arc Welder, Lincoln Model AC180-S or equal
1 Spot Welder, Lectro Spot Model 111
1 Oxy-Acetylene Welding & Cutting outfit, Victor or equal
1 Electric Heat Treating Furnace, Model 1525M-1 Thermolyne or equal
1 Bench Solderning Furnace, Johnson Model 118, 3 Burners or equal
1 Foundry Unit, Broadhead-Garrett or equal
1 Molding Bench for Foundry, Model MB5 Broadhead-Garrett or equal
2 Anvils
1 Welding Booth, Model 4390 with hood, Broadhead-Garrett or equal

CERAMICS

Hand tools used in ceramic shop
1 Electric Kiln, Fine Art Model No. FA-88 or equal
2 Potters Wheels, Amaco No. 1 or equal
Ceramic Spray Booth--Amaco or equal

APPENDIX F

BIBLIOGRAPHY

APPENDIX G

S.E.T. PROJECT
INDEPENDENT STUDY CONTRACT

S.E.T. PROJECT
INDEPENDENT STUDY CONTRACT

INDUSTRIAL EDUCATION

MATERIAL ANALYSIS AND PROCESSING SYSTEMS

THIS AGREEMENT

made this ____________ day of ____________ in the year nineteen hundred

and ____________.

BY AND BETWEEN

________________ hereafter called the Independent Study Student, and

________________ hereafter called the Instructor.

WITNESSETH

that whereas the Independent Study Student intends to plan, organize, build, fabricate or develop: ________________________________

____

____

NOW THEREFORE,

the Independent Study Student and the Instructor, for the considerations hereafter named, agree as follows:

ARTICLE I. The Independent Study Student agrees to provide all the labor and to do all things necessary for the proper construction and completion of the work shown and described on the attached plans and specifications. It will also be the responsibility of the student to keep a daily log of all work done during the contract period.

ARTICLE II. Time of completion

The work to be performed under this contract shall commence and be completed by the following dates:

____________	____________	____________
Beginning Date	Estimated Completion Date	Final Completion Date (on or before)

SIGNED ______________________________ ____________

Independent Study Student — Date

______________________________ ____________

Instructor — Date

EXTENTION OF CONTRACT DATE ____________

____

Day	Description of Completed Work
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

Date Contract Completed: ______________________

Contract Grade: ______________________

Contract Cost for Supplies: ______________________

Date Paid: ______________________

Instructor's OK: ______________________

APPENDIX H

S.E.T. PROJECT SAFETY PERMIT FORM

S.E.T. PROJECT

THE POWER MACHINE OPERATION PERMIT CARD

STUDENT'S NAME ____________ ____________ ____________
Last First Hour

This certifies that ____________ has passed a safety examination in the safe use of materials, tools, and power equipment in the material analysis and processing systems shop with an acceptable score. I believe this student is now capable of using authorized machines and materials and do hereby give my permission for him to use them according to the prescribed safety regulations during class time or other periods when I am in the shop.

____________ ____________
Signature of teacher Date

THIS PERMIT MAY BE CANCELLED AT ANY TIME BY THE TEACHER, PRINCIPAL, OR PARENT

STUDENT'S SIGNATURE

I have received full information in the safe use of materials, hand tools, and power equipment in the material analysis and processing systems shop, and promise to use all such materials, tools, and power machines according to the safety instructions which I received and with due care for the prevention of accidents to myself or others.

____________ ____________
Signature of Student Date

PARENT'S PERMIT

I understand that ____________ has received full instructions in the safe use of materials, tools, and power equipment in the material analysis and processing systems shop and hereby give my permission for him to use the same.

____________ ____________
Signature of Parent Date

APPENDIX I

S.E.T. PROJECT
SAFETY INSTRUCTIONS FORM

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NAME: ____________________

HOUR: __________

DATE: __________

S.E.T. PROJECT
SAFETY INSTRUCTIONS

I have received the Safety Instructions regarding the materials & processes lab and the use of the following equipment. I understand the importance of these rules and regulations, and I am fully aware that the violation of any one of these rules may endanger myself, other, and/or the equipment.

SIGNED ________________________________ DATE __________

After the safety instruction and demonstrations are made on each machine, each student must sign this sheet to prove safety instructions in the safe operation of that machine was given, along with the date on which it was given. It will also be necessary for each student to have the initials of the instructor before the student may use that particular machine.

SAFETY INSTRUCTION GIVEN ON:	STUDENT'S SIGNATURE	DATE GIVEN	INITIAL
CIRCULAR SAW			
BAND SAW			
JOINTER			
DRILL PRESS			
LATHE (Wood & metal)			
BELT & DISC SANDER			
PORTABLE SANDER			
ROUTER			
SCROLL SAW			
ARC–WELDER			
GAS FURNACE			
SQUARING SHEAR			
BUFFER			
OXY–ACET. WELDER			
GRINDER			

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APPENDIX J

S.E.T. PROJECT
PROCESS EVALUATION FORM

MATERIAL ANALYSIS AND PROCESSING SYSTEMS FORM

INSTRUCTIONS: In order to evaluate the completion of the required activity, fill out all the information provided on this form and hand to the instructor. This form will be kept by the instructor in order to provide proof of the completion of each activity.

STUDENTS NAME ______________________________ Class Period _______

State the name of each process that was performed during the activity. Example: casting, lamination, compression molding, etc. ______________________________

____

____

____

Estimated time for completion of activity: ______________________________

Give the correct name of the material or materials that were used for the activity. Example: black walnut, aluminum alloy, acrylic plastic, etc. ______________________________

____

____

1. Organic
2. Inorganic

The material used for this activity is classified as: Circle correct answer

1. Thermoplastic
2. Thermosetting

1. Hardwood
2. Softwood

1. Non-ferrous metals
2. Ferrous metals

1. Others (state):

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Date: 1962

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Author: William Olson
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